AMORIM

PRICEWATERHOUSECOOPERS

ECOBILAN

Evaluation of the environmental impacts of Cork Stoppers versus Aluminium and Plastic Closures

Analysis of the life cycle of Cork, Aluminium and Plastic Wine Closures

Report prepared for

CORTICEIRA AMORIM, SGPS, SA

October 2008

Prepared by **PricewaterhouseCoopers/ECOBILAN**

CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY OF THE SURVEY

1 Context of the survey and approach taken

Corticeira Amorim has requested the aid of **PricewaterhouseCoopers/Ecobilan** to quantify and compare the environmental impacts of cork stoppers versus aluminium and plastic closures on the UK market of wine. The closures considered in this study were: the Natural cork stopper produced by Amorim & Irmãos[1] in Portugal (Santa Maria de Lamas) with dimensions 45mm X 24 mm and 3,5 g of weight; a typical aluminium closure produced in France with dimensions 60 mm x 30 mm and 4,6 g of weight and a typical plastic closure produced in Belgium with dimensions 43 mm x 22 mm and 6,2 g of weight.

The survey was carried out using the methodology of life cycle analysis (LCA) supported by data from the different process units of Corticeira Amorim and from bibliographic sources, namely internet research, and complemented using the Ecobilan LCA database.

This survey does not use proprietary information from the producers of aluminium and plastic closures.

Life cycle analysis is a standard method which allows evaluation of the potential impacts of a product or service on the environment during all stages of its life, from the extraction of natural resources to final waste processing. The survey was carried out in conformance with the ISO 14040 series of standards.

To evaluate the potential impacts of natural and synthetic wine closures on the environment, the survey proposed seven indicators: non-renewable energy consumption; water consumption; emission of greenhouse gases; contribution to atmospheric acidification; contribution to the formation of photochemical oxidants (ozone layer depletion); contribution to the eutrophication of surface water and production of solid waste.

On completion of this survey Corticeira Amorim intends to publish this study to the public, in accordance to ISO 14040 and ISO 14044, and submit it to a critical review by an independent committee including external experts and interested parties:

- An independent life cycle analysis (LCA) expert (Mr. Yvan Liziard);
- An independent specialist on cork (Mr. João Santos Pereira, from Instituto Superior de Agronomia of Universidade Técnica de Lisboa);
- Plastic association (Association of Plastics Manufacturers in Europe).

Besides these entities, an aluminium association was also contacted, but did not accept to cooperate in the review process.

The comments of the various members of the independent committee to the temporary version of this LCA report are presented in section VI, together with the corresponding response of PwC/Ecobilan.

[1] 100% owned by Corticeira Amorim SGPS, S.A.

2 Results relative to the contribution of industrial stages for each closure studied

The production phase predominates for all the indicators considered (except for solid waste production, where end of life phase predominates).

Using the LCA indicators selected in the report, environmental impact associated to the production phase is significantly higher for aluminium and plastic than for cork closures, for all the studied indicators. This is due to the high impact of production of aluminium and plastic, when compared with cork.

In terms of improving the performance of these two types of closures (aluminium and plastic), this means that a reduction in the unit weight of a closure (whilst maintaining its technical properties) will be the main alternative for the improvement of their environmental behaviour.

Bottling has similar impact for cork and plastic closures, since the bottling processes are identical. In the case of cork stoppers, this is the phase of the life cycle with the highest environmental impacts, mainly associated to the PVC cover.

Although most representative in the case of cork stoppers, since the stoppers are transported from Portugal to the UK (aluminium closures come from France and plastic closures from Belgium), whatever the closure considered, transport has a minor impact in the total emissions of closures, when comparing with other phases (namely production and bottling).

Regarding the end of life stage, the recycling of plastic closures results in beneficial impact for some of the studied indicators, corresponding to the avoidance of production of new plastic and associated adverse impacts. In the case of aluminium, this beneficial impact is included in the model through the introduction of recycled aluminium as a secondary material for food packaging products (in the case of plastic this is currently not possible due to food safety and hygiene requirements).

3 Comparative environmental appraisal of the three types of closures

The comparison of the environmental impacts of the three types of closures was carried out on the basis of an identical service rendered: sealing one thousand bottles of 0.75 litter of wine, i.e. the typical unit of wine packaging purchased, sold on the UK market.

This comparison was affected by:

- The context of the UK situation of processing household waste;
- The context of aluminium recycling in France (35% of the total aluminium put on the French market comes from recycled aluminium)[2];
- Synthetic (aluminium and plastic) closures production data is not publicly available; the present study has not taken into account production data. Only production of the intermediary materials is included. This assumption disfavours cork;
- Bottling of wine is assumed to be performed in the UK in order to simplify the modeling. This assumption is common to the three types of closures (cork, aluminium and plastic).

[2] Association Francaise de l'Aluminium

These differences and other exclusions described at the report have to be taken in account when comparing environmental performances of the different closures. Considering that in this survey we adopted always the worse scenario for cork stoppers, this remark is mainly applicable for the comparison of the environmental performances of aluminium and plastic closures.

In this context, the main results of this comparison are:

- In comparison to the aluminium and plastic closures, the cork stopper is the best alternative in terms of non-renewable energy consumption, emission of greenhouse effect gases, contribution to atmospheric acidification, contribution to the formation of photochemical oxidants, contribution to the eutrophication of surface water and total production of solid waste;
- In comparison to the cork and plastic closures, the aluminium closure is the best alternative in terms of consumption of water, followed by cork stoppers.
-

Environmental Indicator	Type of stopper		
	Cork Stopper	Aluminium Stopper	Plastic Stopper
Non-renewable energy consumption	1.00	4.46	5.00
Water consumption	1.88	1.00	3.07
Emission of greenhouse gases	1.00	25.84	10.23
Contribution to atmospheric acidification	1.00	6.61	1.63
Contribution to the formation of photochemical oxidants	1.00	4.22	1.49
Contribution to the eutrophication of surface water	1.00	1.10	1.52
Production of solid waste	1.00	1.99	1.58

Table 1: Relative performances of the different closures studied

Key:

(light green)	Best Performance
(dark green)	Performance poorer by less that 20 % in relation to best performance
(red)	Performance poorer by at least 20 % in relation to best performance

In conclusion, for the market and packaging application considered, cork stoppers is therefore better than the aluminium and plastic closures for all indicators, except for water consumption, which is the only weakness of this stopper.

In order to test the strength of the preceding observations, several variations of the basic scenario were considered (additional information supplied in chapter 21):

- **Composition of plastic closures:** Variation of the percentage of High Density Polyethylene (HDPE) and Polypropylene (PP). The following options were considered:
  - 68% Low Density Polyethylene (LDPE); 16% High Density Polyethylene (HDPE); 16% Polypropylene (PP);
  - 68% Low Density Polyethylene (LDPE); 32% High Density Polyethylene (HDPE);
  - 68% Low Density Polyethylene (LDPE); 32% Polypropylene (PP)).
- **Cork behaviour in landfill:** Profile of the cork stopper with a different amount of landfill gas produced (0,05 kg gas/kg product and 0,15 kg gas/kg product).
- **Carbon sink associated to cork forestry:** Analysis of emissions of greenhouse effect gases considering the carbon sink associated to the cork oak forest, indirectly associated to Corticeira Amorim's activities;
- **Impact of plastic closures recycling:** Analysis of the importance of avoided impacts associated to recycling, when compared with the impacts associated with the rest of the phases of the life cycle of plastic closures;

- **Impact of aluminium closures recycling:** Analysis of the importance of avoided impacts associated to recycling, when compared with the impacts associated with the rest of the phases of the life cycle of aluminium closures.

Generally speaking, these variants did not significantly modify the previous observations with regard to the position of cork stoppers in relation to the aluminium and plastic closures. In this survey we adopted always the worse scenario for cork stoppers.

4 Potential for development / modification

Cork Stoppers recycling

According to Corticeira Amorim cork is a 100% recyclable product, constituted by around 50% of carbon that is fixed by the cork oaks and stored in the cork through photosynthesis process. Therefore, besides other environmental advantages the recycling of cork delays the reemission of fixed carbon into the atmosphere.

Although used cork stoppers are recyclable, there are only a few occasional initiatives to collect and recycle them and therefore in this survey we have not considered the recycling of used cork stoppers.

In this context, Corticeira Amorim has previewed for 2008 the development and implementation of a structured plan to increase the recycling of cork stoppers, through its incorporation in new cork products.

Cork stoppers behaviour in landfill

The available information regarding cork behaviour in landfill is not sufficient; in this survey it was considered that cork's behaviour would be similar to wood in terms of biogas production.

Additional studies on this matter are necessary and will allow the validation of the adopted assumption. Corticeira Amorim has started a project with this objective.

Performance of the different closures as wine closures

Failure rates for all types of closures – cork, aluminium or plastic – have not been assessed using strictly scientific methodology. As a result, screwcap-induced reduction, cork-induced TCA or plastic-induced oxidation are often mentioned in international media as commonly occurring faults that can negatively impact wine; but no hard quant data exists that details such failure rate for any of the closures under assessment in this LCA. In the absence of fact-based knowledge, the functional unit selected does not include this information.

When this information is available for the three types of closures, it wil be possible to make a new survey considering a different functional unit and including this information.

Environmental impacts associated to wine production and transport

There are no global, encompassing studies using strictly scientific methodology that can give reliable info for life cycle impact of wine. Corticeira Amorim is aware, however, that the wine industry has in progress some important studies on this matter. When this information is available, it wil be possible to make a new survey considering a different functional unit and including this information.

SECTION I – General introduction

1 Context of the survey

Corticeira Amorim is the biggest producer of cork products in the world, transforming and commercializing 30% of world cork production, in more than 100 countries. Besides the cork stoppers for wine products, the group has a vast portfolio of products, for application in diversified industries such as construction, automotive, aeronautical and others.

For centuries, cork stoppers have been the closures of wine bottles. This natural environmentally friendly and renewable material is associated to a product-integrated manufacturing process that is practically waste-free, since cork waste is used for the production of energy.

In the XXth century most of natural products have been replaced by synthetic products. Aluminium and plastic closures are the new comers to the market of wine bottle closures.

In order to differentiate cork stoppers, one of the main challenges identified by Corticeira Amorim and also by their Stakeholders during a consultation process was the identification and promotion of the advantages of cork. In this context, Corticeira Amorim decided to evaluate and compare the environmental impacts of the different types of closures through a life cycle analysis survey.

In addition to benefiting from the ecological characteristics of cork, Corticeira Amorim has structured its business activities around the adoption and strengthening of sustainable development practices, using best practices that can reinforce the character of the product as a way of enhancing differentiation regarding alternative products.

At this stage, Corticeira Amorim decided to assess and communicate the impact of cork stoppers compared with aluminium and plastic closures.

To make the LCA of cork, Corticeira Amorim has collected manufacturing data from their own sites.

Regarding aluminium and plastic closures, only published data, related to the raw material production has been used. Data directly related to the aluminium and plastic closures production process was not publicly available and therefore has not been considered within the survey. As a result, the impacts of both synthetic products are underestimated in comparison with the cork stopper.

2 Objectives of the survey

The survey aims to quantify the environmental impacts of cork stoppers versus aluminium and plastic closures on the UK market of wine.

The objectives of this survey are:
- To identify opportunities to improve the environmental performance of cork stoppers;
- To provide additional information to the wine industry, namely to wineries that want to have a responsible and environmentally friendlier choice;
- To prepare a firm and quantified argument on which Corticeira Amorim can call when comparing cork stoppers with alternative materials.

Corticeira Amorim will use the results of the survey in its policy and in the activities carried out by its sales units all over the world.

3 Organisation of this report

This report is organised as follows:

- Sections II and III describe the products considered, the systems studied, the nature and sources of data collected and the calculation hypotheses adopted;
- Sections IV and V present the results of the survey, their interpretation and the conclusions of the report;
- Sections VI set out the external critical review of this life cycle analysis (LCA).

The appendices complement the body of the report:

- Appendix I presents one life cycle analysis report on cork stoppers;
- Appendix II presents the life cycle analyses and the methods of evaluating the potential impacts on the environment;
- Appendix III specifies the sources of secondary data;
- Appendix IV presents the inventories of the life cycle analyses calculated during this survey.

SECTION II - Definition of the field of research

4 Methodology used

This report has been prepared in conformance with the methodological stipulations of the following standards: ISO 14040 and ISO 14044.

In conformance with these standards, sensitivity analyses have been carried out to observe the influence of certain hypotheses on the results of the survey (see section 21).

5 Functional unit and products studied

5.1 Functional unit

Each one of the different closures considered on this survey is studied for an identical service rendered to customers.

The functional unit considered on this survey is sealing a standard bottle of wine bottled sold on the UK market. The results are presented using one thousand wine closures as the reference flow.

All the three types of closures (cork, aluminium and plastic) can be used for sealing standard 750 ml wine bottles.

5.2 Description of the wine closures studied

Three wine closures were studied in this LCA, as referred in section 1:

- Natural cork stopper produced by Corticeira Amorim;
- A typical aluminium stopper;
- A typical plastic stopper.

The major characteristics of each type of wine closure considered are shown in Table 1 below.

This survey does not include information from aluminium or plastic closures producers.

	Closure		
	Cork Stopper	**Typical Aluminium Closure**	**Typical Plastic Closure**
Name	Natural cork	-	-
Producer	Amorim & Irmãos	-	-
Place of production	Portugal - Santa Maria de Lamas	France (East of France)	Belgium
Dimensions (mm x mm)	45 x 24	60 x 30	43 x 22
Weight (g)	3,5	4,6	6,2
Composition	100% Cork	89,9% Aluminium 7% Expanded PET – 2% TIN 0,5% Kraft 0,6% PVDC	68% Low Density Polyethylene (LDPE) 16% High Density Polyethylene (HDPE) 16% Polypropylene (PP)

Table 2: Description of wine closures studied

Plastic closures include interior foam (LDPE) and an external layer, composed by a mixture of HDPE and PP. Information on the precise composition of the external layer of the closure was not available, since the patent of the closure refers the inclusion of High Density Polyethylene and Polypropylene, but not the corresponding percentages. In this study it has been considered that this layer is a compound of 50% High Density Polyethylene and 50% Polypropylene. A sensitivity analysis on this issue was performed and results are presented in section 21.

6 Boundaries of systems studied

6.1 Presentation of systems corresponding to the reference scenarios

The aim of the following sections is to present, for each wine closure considered (cork, aluminium and plastic), the system used to describe its life cycle. The systems have been broken down according to a structure common to all closures, comprising the following sub-systems:

1 - Production of raw materials;
2 - Transport of raw materials;
3 - Production of closures;
4 - Transport of closures;
5 - Bottling;
6 - Use of closures;
7 - End of life.

In the studied scenario, bottling is made in the UK for the three kinds of closures. This scenario corresponds to the latest tendencies on this issue and it is considered to lead to a minimization of environmental impacts.

Cork and plastic closures are accompanied by PVC cover whose production impact has been taken into account.

Energy consumption associated to bottling activities was not considered for any of the types of closures considered, due to lack of information.

The life cycle phase corresponding to the use of the closures by the consumers was not considered for any of the studied closures, since it is not associated to significant environmental impacts and is expected to be very similar for the three materials.

6.1.1 Life cycle of cork stoppers

The system studied refers to the complete life cycle of cork stoppers, from extraction of the cork from the trees, through production of the stoppers, up to disposal of used cork stoppers at the end of their life, after use by the consumer.

Cork products and related activities are directly and indirectly associated to carbon sink, as explained next:

- The capture of carbon by the cork oaks during the photosynthesis process results in plant growth and transforms atmospheric CO_2 into O_2 and, in the case of organic matter, into cellulose. For this reason the forest is considered to be an important carbon sink. Considering that the exploitation of the cork oak forest is largely made possible by the activities of Corticeira Amorim, the positive impact on carbon capture of the oak forest could be indirectly attributed to Corticeira Amorim;
- Since 50% of cork is carbon, and considering that this carbon results from the fixation of CO_2 during photosynthesis process, it can be assumed that each cork stopper is responsible for a determined amount of CO_2 corresponding to the conversion of C into CO_2.

In this survey it was only considered the carbon sink associated to cork stoppers, since this is directly related to Corticeira Amorim's products. However, in order to demonstrate the indirect positive impact on carbon capture of the oak forest corresponding to Corticeira Amorim's activities, a simulation of carbon sink using this hypothesis was performed and is presented in Section 21.

Transportation between the different phases of the cork stoppers life cycle was considered, except after the bottling site since this will be the same for the three types of closures and can be allocated to the wine itself, not the stopper.

Figure 1 summarizes the principal stages taken into account for the cork stopper. The grey boxes indicate phases where impacts have not been evaluated, as in the case of use phase, as described earlier. The transport stages taken into account are represented by the symbol "T".

Cork Harvesting

Cork is extracted from the wild cork oak trees once every nine years. The process of cork extraction is called stripping and is carried out manually in late spring and summer when the cork producing tissue (cork cambium) is active. Then a new bark begins to form behind the newly exposed trunk surface. The stripping is a highly specialised process that guarantees that the tree is not harmed, otherwise it would die.

The cork oak is a slow growing tree that may live for 200 years, which allows it, on average, to be stripped 16 times during its lifetime. The first stripping only takes place after 25 years, when the trunk of the tree has a circumference of 70 cm. The bark removed in this first extraction is called virgin cork; nine years later the secondary cork is extracted. After these two extractions, reproduction cork is extracted every nine years, regular in structure, with smooth internal and external surfaces, and the characteristics and qualities that make it suitable for the production of cork stoppers.

Regular extraction of the cork is a fundamental contribution for environmental, economic and social sustainability of the rural areas of the Mediterranean region where the cork oak may be found.

Environmentally, the role of the cork oak forest in fixing CO2, in preserving biodiversity and in combating desertification is fundamental.

In Portugal, these forests are protected by law and the felling of cork oaks is not permitted save for essential thinning or to remove trees decrepit with age.

No chemical products are used at this stage of the process.

The transport of cork planks to the treatment site is carried out by trucks with a maximum load of 24 tonnes. A medium distance of 150 km was assumed in this survey.

Cork treatment

Following the harvesting, cork is seasoned and sorted prior to processing.

Corticeira Amorim has two cork treatment sites: Coruche and Ponte de Sôr. In these sites, each consignment is tagged and recorded, so that each batch of cork can be traced back to its source in the forest.

After seasoning, cork is boiled to remove organic solids and to bring it to the correct moisture content for processing (13-14 per cent relative humidity). This is performed in closed steel tanks fitted with a special device known as CONVEX® that continuously traps and removes volatile organics such as trichloroanisole (TCA) from the washing water.

Based on the thickness of the cork plank and its porosity, the planks are classified (different types of quality) and assigned to different production processes:

- 30% of the treated cork is used in cork stoppers;
- 70% of the treated cork is to produce other cork products like cork disks or granules for several cork applications.

Natural stoppers production

The natural stoppers production site receives treated cork from:

- Coruche;
- Ponte de Sôr;
- Other sources in Portugal (not produced by Corticeira Amorim);
- Spain (not produced by Corticeira Amorim).

Only 32,5% of this treated cork is to be transformed in stoppers (natural and colmated), the other 67,5% are co-products. 34% of the amount of cork transformed in stoppers is used for the production of 45x24 natural stoppers.

The cork planks are cut into strips with specific widths for desired sizes, which are punched with devices that mould the cylinders. This process causes great amounts of cork waste that is incorporated into other high value applications or valorised as an energy source (biomass).

Using an abrasive stone, the punched corks are polished to the required length and diameter. The polished corks are sorted by a machine, which photographs and classifies each cork by quality into categories. The categories correspond to the number of lenticels or defects visible in the body of the cork - those with the most lenticels are used for lower-grade products such as colmated corks.

Next, cork stoppers are washed in a solution of hydrogen peroxide (H_2O_2) to bleach and sterilise the cork and eliminate microorganisms that might contribute to cork taint and finally the corks are dried in industrial ovens or with sterilised air to the correct moisture content.

Natural stoppers finishing

After drying, the cork stoppers are sorted again - this time by hand - to the customer's specifications; then, if required, they are branded or printed with the identifying mark or logo of the distributor or winery.

A thin film of paraffin wax and/or silicone is applied to each cork, to make it easier to insert into and extract from the wine bottle. This product is taken into account.

Bottling

The bottling process includes the inclusion of a PVC cover, which is included in the cork system.

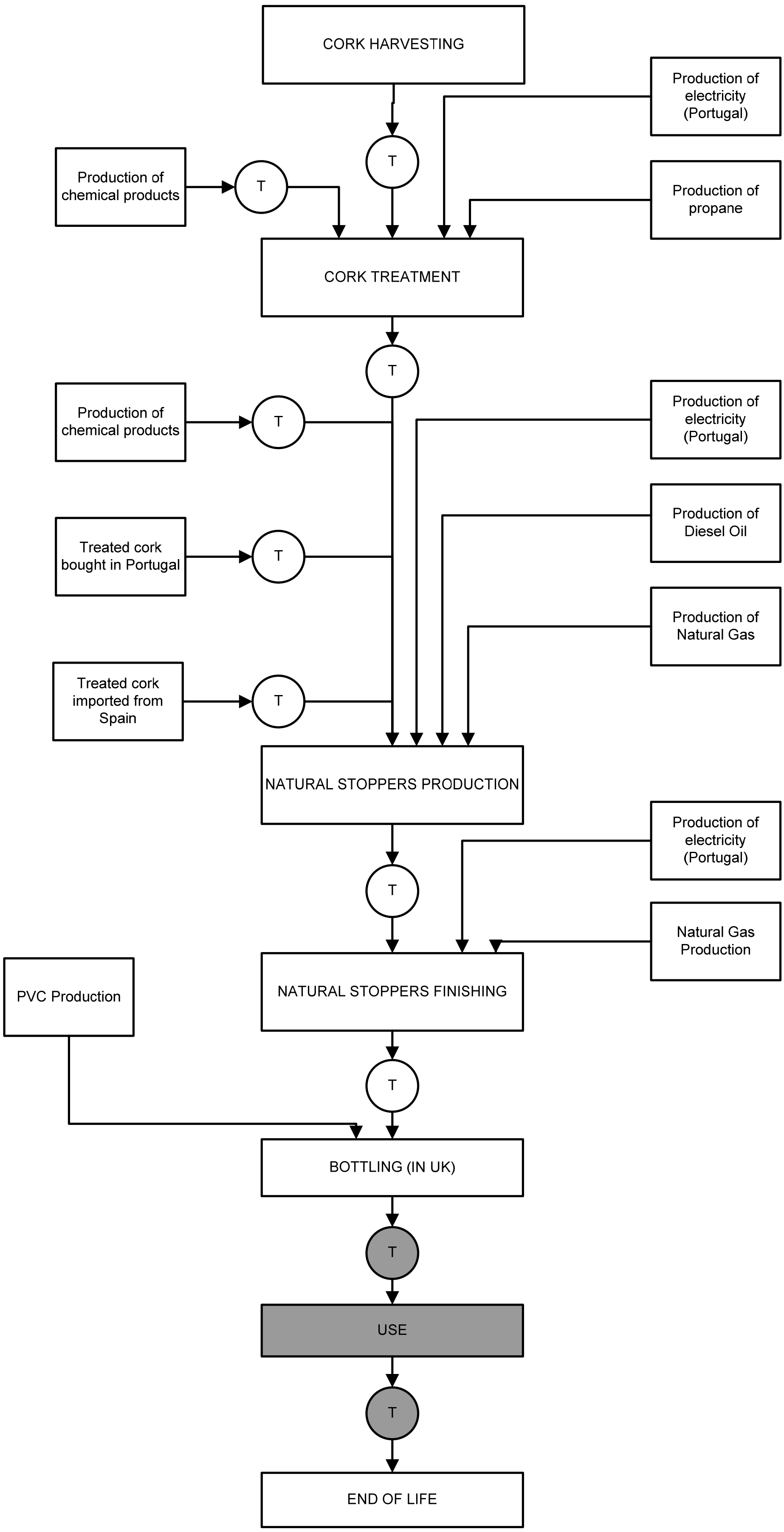

Figure 1: Life cycle system of cork stoppers

6.1.2 Life cycle of aluminium closures

The system studied in this survey does not refer to the complete life cycle of aluminium closures, since it does not include every phase. Phases included are: from the extraction of the natural resources to the production of aluminium sheets, transport of aluminium sheets to the closures production site, transport of aluminium closures from the production site to bottling centres in UK and the disposal of used aluminium closures at the end of their life, after use by the consumer.

In this survey, the environmental impacts associated to the production of the aluminium closures were limited to the production of the necessary amounts of different components of the closures, including the ink used for covering the aluminium closures.

The process for the production of aluminium closures from the aluminium sheets was not included, due to lack of information available in the public domain.

Transportation from the bottling site to the wine shop/supermarket and then to consumers' homes were not included since this will be the same for the three types of closures.

Figure 2 summarizes the principal stages taken into account for the aluminium stopper. The grey boxes indicate the modules where impacts have not been evaluated due to lack of information (aluminium closures production, bottling and some transport stages) and due to other reasons (use, as described earlier).

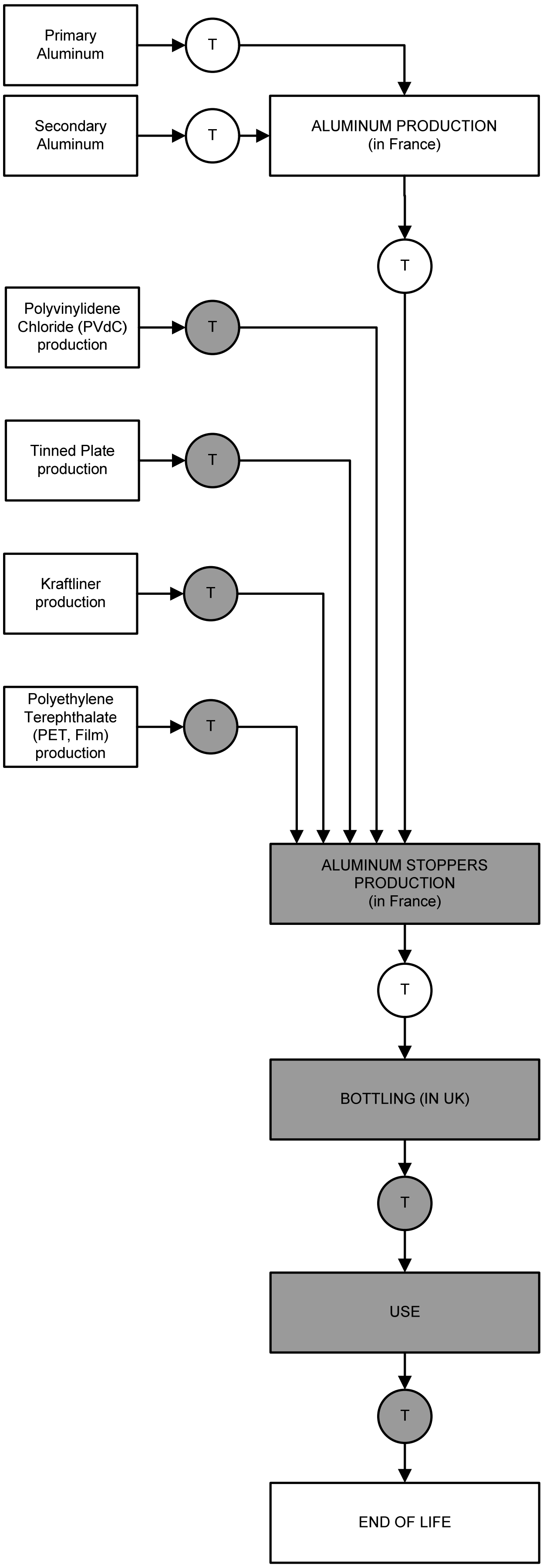

Figure 2: Life cycle system of aluminium closures

6.1.3 Life cycle of plastic closures

The system studied in this survey does not refer to the complete life cycle of plastic closures, since it does not include all phases. Phases included are: from the extraction of the natural resources to the production of different types of plastic granules used as raw material for the closures production, transport of plastic granules to the production site, transport of plastic closures from the production site to bottling centres in UK and the disposal of used plastic closures at the end of their life, after use by the consumer.

In this survey, the environmental impacts associated to the production of the plastic closures were limited to the production of the necessary amounts of components/intermediary materials of the stopper: PVC, tin plate, kraftliner and PET.

The process for the production of the plastic closures was not included, due to lack of the available information.

Transportation from the bottling site to the wine shop/supermarket and then to consumers' homes were not included since this will be the same for the three types of closures.

The bottling process includes the inclusion of a PVC cover, which is included in the cork system.

Figure 3 summarizes the principal stages taken into account for the plastic stopper. The grey boxes indicate the modules where impacts have not been evaluated due to lack of information (plastic closures production and some transport stages) or due to other reasons (use, as described earlier).

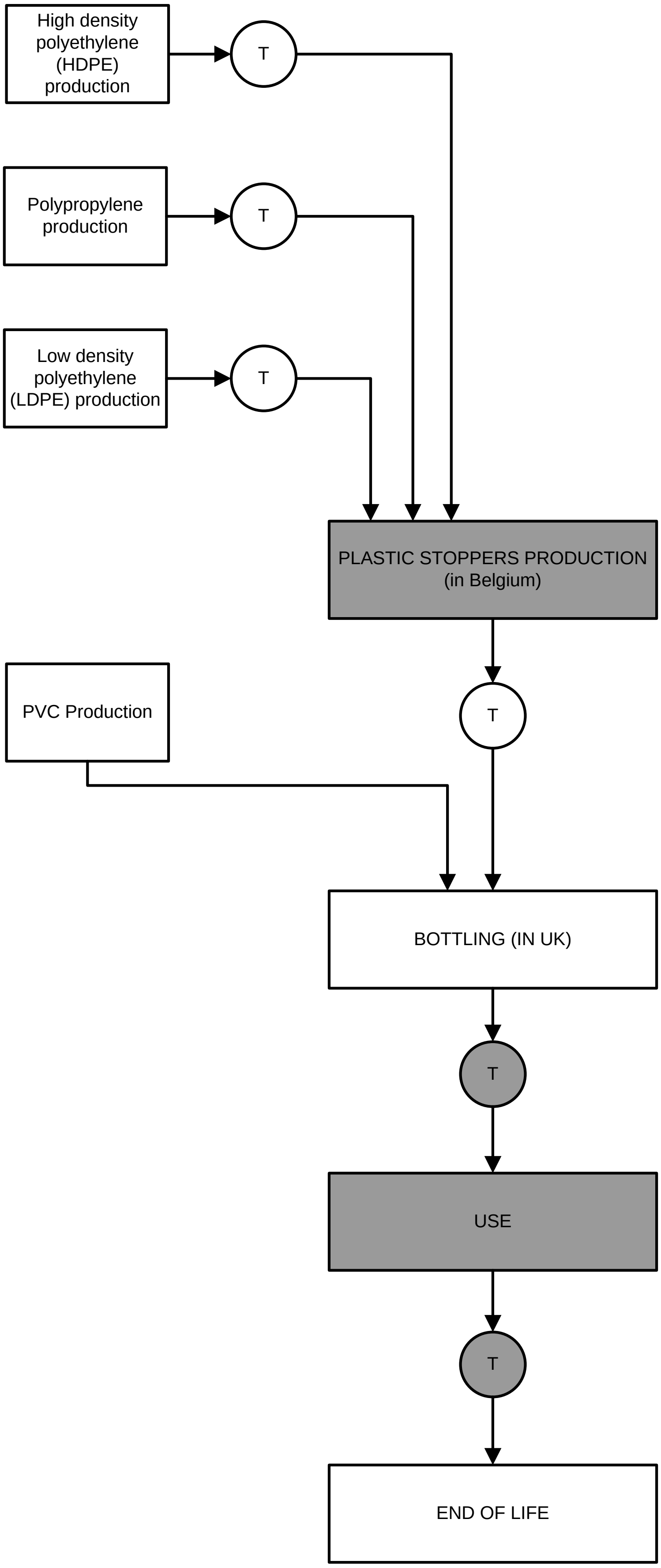

Figure 3: Life cycle system of plastic closures

6.2 Delimitation of system boundaries

6.2.1 Delimitation rules

To precisely delimitate the system boundaries with accuracy, i.e. to decide if the production or rate of a reagent or material must be taken into account, a systematic rule has been used in this project:

1. Regarding the production of a consumable

In the case of cork stoppers, if the data is available, the production of the referred consumable is systematically taken into account, even if the quantity consumed is low. In some cases where exact composition of the products was unknown, approximations have been done, The assumptions adopted are described in section 12.

In the case of aluminium and plastic closures, only the main raw materials where considered, due to lack of information available in the public domain.

2. Regarding final destination of waste:

- for the cork stoppers process, wastes that represent less than 1% of the total mass of wastes, were not included.

6.2.2 List of excluded life cycle stages

According to ISO 14040, certain categories of operations may be excluded from the systems with the condition that this is clearly stated. These exclusions have to be taken in account when comparing environmental performances of the different closures. Considering that in this survey we adopted always the worse scenario for cork stoppers, this remark is mainly applicable for the comparison of the environmental performances of aluminium and plastic closures.

The following sections specify the secondary stages which have not been taken into account within the context of this project because:

1. Lack of information in the public domain

- Paints used in PVC covers for cork and plastic closures ;
- Energy consumption in bottling activities, for all types of closures;
- For aluminium and plastic, production of closures was not included. This survey only includes the production of the necessary intermediate and raw materials.

2. Methodological reasons: impacts are allocated to other products

- Final destination and transportation of wastes from the production site of closures;
- Transport after the bottling site since this will be the same for the three kinds of closures.

3. Negligible impacts

- The systems studied exclude construction of buildings on industrial sites (paper mill, cardboard mill, refinery…) and fabrication of tools and machines.
  In effect, stabilised operation of each of these systems is assumed, i.e. the impact on the environment linked to construction and demolition of the buildings and equipment is absorbed over the whole of their period of use. As experience has shown that these impacts on the environment are negligible compared with those linked to operation, this hypothesis is justified within the context of this project;
- Energy consumption in administrative areas and laboratory, for all types of closures studied;

- Transport of workers related to the extraction of raw materials was not included, for all types of closures considered (e.g. transport of workers to the forest for the harvesting of cork, that represents around 1% of total CO2 emissions associated to cork stoppers).

6.3 Allocation procedures for by-products

The principal stages described in the different systems of the survey do not include any by-products, except for the cork stopper production step.

The distribution and use of cork, from forest to different applications, is described in Figure 4.

As described in the Figure below, 30% of the cork harvested is used for stoppers, and from those, only 32,5% is transformed in cork stoppers (the remaining 67,5% are by products). There are several types of stoppers produced, and the amounts of cork used to produce natural stoppers correspond to 34% of the cork used for stoppers (3,3% of the total cork harvested).

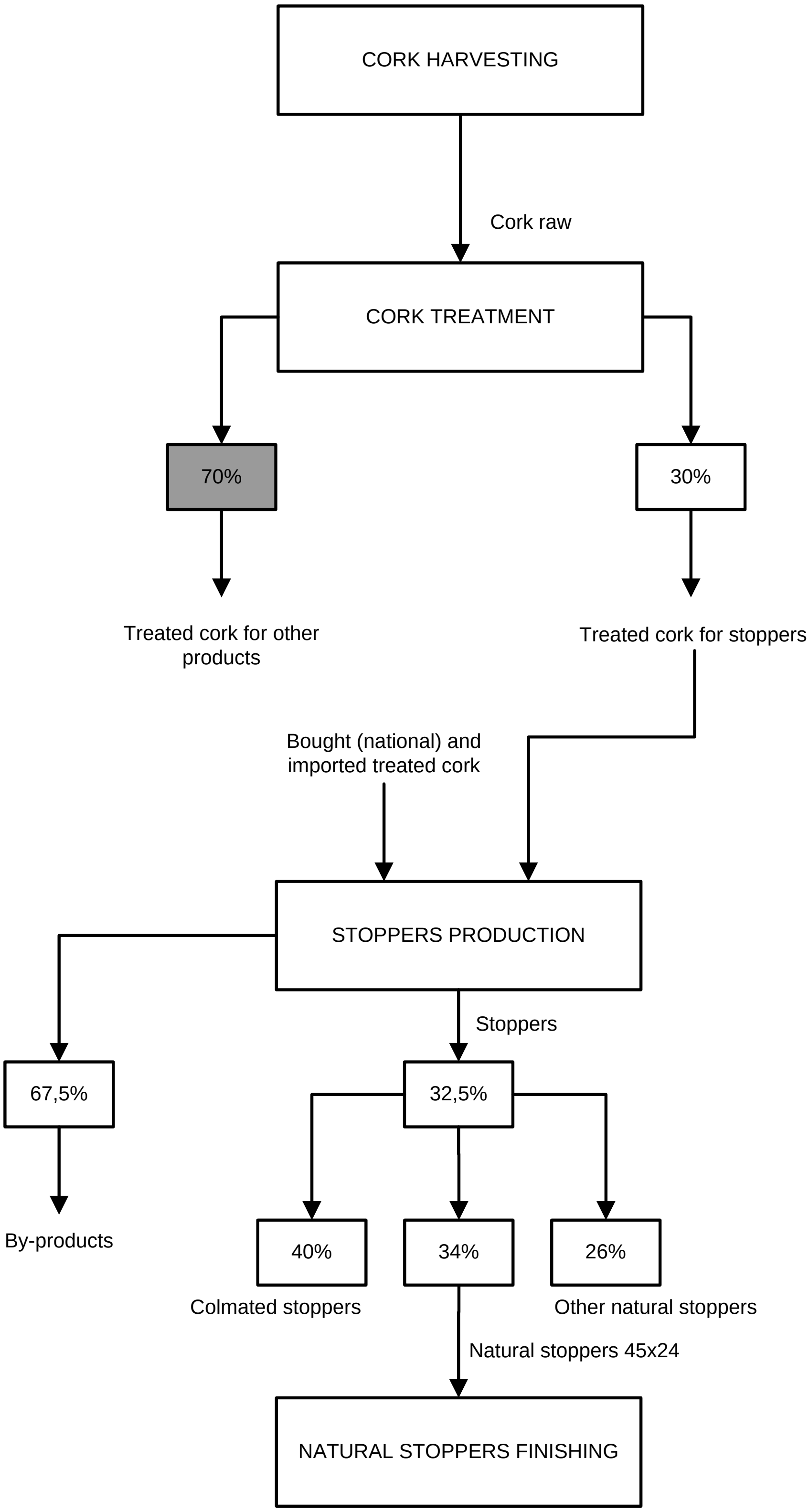

Figure 4: Distribution and use of cork

At the stoppers production site, where several types of stoppers are produced, there are some general process steps through which all treated cork goes and some secondary/specific process steps that concern only some products. Since the production of natural stoppers consists only of general steps, it is possible to use a mass allocation in this model, thus preventing using formulas to allocate the different flows to the studied product.

In this context, the stopper production model:

- Takes into account only general process steps that are part of the natural cork production process;
- Considers the total quantity of cork entering the site as well as the total quantity of cork leaving the site in order to evaluate an impact per kg of cork.

6.4 Allocation procedure for recycling

The way the modeling was conceived was the following:

- The recycling of post consumer waste is taken into account through a reduction of waste treatment and the inclusion of the recycling stages until the entry into a recycling stock ("usable products leaving the system").
- A balance is then performed between usable products leaving the system (UL) and usable products entering the system (UE).
  - If UL>UE, a credit corresponding to the production of UL-UE kg of virgin products is considered for the stopper. This is the case for plastic stoppers.
  - If UL<UE, a debit corresponding to the production of UE-UL kg of virgin products is considered for the stopper.
  - If UL=UE, no further action is taken. This is the case for aluminum.

These allocation procedures between the successive uses of recycled materials are consistent with ISO 14044, §4342 Allocation procedure: "Allocation procedures shall be uniformly applied to similar inputs and outputs of the system under consideration. For example, if allocation is made to usable products (e.g. intermediate or discarded products) leaving the system, then the allocation procedure shall be similar to the allocation procedure used for such products entering the system."

6.5 Consideration of energy and material values

Modelling of the end of life sub-systems for wine closures described in section 17.

7 Environmental flows and impacts studied

7.1 Environmental flows and energy indicators

All the environmental flows (e.g. consumption of water, emission of pollutants to air, ground and water) have been evaluated as part of this project. The results in relation to all the environmental flows are presented in the LCA inventories in Appendix IV. Flows identified as important and for which the potential impact indicators are more precisely analyzed in section IV of this report are as follows:

- Natural resources: consumption of diesel oil, propane gas, natural gas, wood, cork waste and water;
- Emissions to air: CO_2, CH_4, N_2O, NOx, SOx, particles;
- Emissions to water: phosphorous and nitrogen waste and oxidisable substances contributing to the chemical demand for oxygen;

- Production of waste: total production of waste.

7.2 Environmental impact indicators

The following impact indicators are calculated and analyzed on the basis of the environmental and resource consumption flows:

Indicator	Milieu concerned	Calculation Method	Robustness
Greenhouse effect in 100 years This indicator takes into account emissions of fossil CO_2 and N_2O (these emissions coming, for example, from the combustion of fuel and natural gas) and CH_4 emission (coming for example from the fermentation of discarded paper). On the other hand, the indicator does not take into account biomass CO_2 emissions resulting, for example, from the combustion of paper in an incinerator. The greenhouse effect is expressed in kg CO_2 eq.	AIR	IPCC: International Panel on Climate Change, 1998	High
Atmospheric acidification Based on emissions of NO_x, SO_x, HCl, this indicator characterises the increase in quantity of acid substances in the low atmosphere, at the cause of acid rain and also the decline of certain forests. Atmospheric acidification is expressed in g. eq. H+.	AIR	ETH: Ecole polytechnique [higher education establishment] specialising in energy systems, Zurich, Switzerland, 1995	High
Formation of photochemical oxidants In certain climatic conditions, atmospheric emissions from industry and transport can react with solar photons and produce a photochemical smog. A succession of reactions involving volatile organic compounds and NO_x, leads to the formation of ozone, a super oxidizing compound. The potential to form photochemical oxidants is expressed in g. ethylene eq.	AIR	WMO: World Meteorological Organization, 1991	High
Eutrophication of water Eutrophication of an aqueous milieu is characterised by the introduction of nutrients in the form of phosphatised and nitrogenous compounds for example, which leads to the proliferation of algae. Eutrophication is expressed in g eq. phosphates.	WATER	CML: Leiden University (The Netherlands), 1992	Average

Table 3: Analysis of environmental impact indicator

The impact indicators adopted are recognized environmental indicators in the area of life cycle analysis.

These environmental impact indicators are given in Appendix II along with their significance and the coefficients used in their calculation.

7.3 Indicators used to evaluate the environmental performance of closures

The following indicators, covering environmental flows, energy indicators and environmental impact indicators have been used to characterize the closures results in section IV:

- Energy consumption;
- Water consumption;
- Greenhouse gases emissions;
- Atmospheric acidification;
- Contribution to the formation of photochemical oxidants;
- Contribution to eutrophication;
- Solid waste production.

Indicators were chosen taking into consideration the following:
- They represent the most typical and well-known indicators for LCA;
- They evalaluate the most important environment impacts for the stoppers production activity;
- Indicators that were selected by similar studies done (e.g. Life Cycle Assessment of a single-piece natural cork stopper for oenological use described in Appendix I);

7.4 Indicators not used to evaluate closures performance

The following indicators have not been adopted to evaluate the environmental performance of the closures: Emissions of dioxins and heavy metals by household waste incinerators were not adopted.

Emissions of dioxins by household waste incinerators.

This indicator has not been adopted because:

- The rate of waste incineration in UK is not significant (11%)[3] and the emissions from incinerators have been dropping in the past years: dioxin emissions have declined 82% over the period 1990 to 2005 and dioxin emissions from waste incineration have fallen by 80% between 1993 and 2005[4];
- Closures waste is either recycled or landfilled.

Emissions of heavy metals by household waste incinerators.
This indicator has not been adopted since the wine closures contain no (or very few) heavy metals. The major source for this type of products is the inks used in cork, aluminium and plastic closures, and the inks used currently no longer contain heavy metals.

8 Requirements relative to the quality of data

This survey aims to analyse the environmental assessment of the life cycle of 3 types of wine closures. According to ISO 14040, requirements relative to the quality of data cover the following criteria:

- **Time factor**: the data used is representative of the current situation;

[3] UK DEFRA, Department for Environmental Food and Rural Affairs
[4] UK National Atmospheric Emissions Inventory

- **Geography:** the survey is representative of the use of wine closures in UK - bottling is made in the UK in the studied scenario since it was assumed that the bottling process is made in the wine consumer country

The transport distances used to describe the transport stage of the different closures correspond to the distance between the place of production of the different closures and the place of bottling. The distances considered correspond to the average distances between the two major bottling centres, in Bristol and Manchester. Taking into account the logistical similarities (road transport, type of truck, maximum load, actual load and fuel consumption) between the main countries involved in the survey (Portugal, France, Belgium and UK), the transport hypotheses can also be considered representative of the European situation. The electricity models adopted for the production and transport of the closures correspond to the country in which these are manufactured, namely:

- Portugal, for the cork stoppers;
- France, for the aluminium closures;
- Belgium, for the plastic closures.

- **Technology:** the data reflects current technology.

9 Critical review

On completion of this survey, Corticeira Amorim instigated an independent critical review of the results by an independent committee including external experts and interested parties:

- An independent life cycle analysis (LCA) expert (Mr. Yvan Liziard);
- An independent specialist on cork (Mr. João Santos Pereira, from Instituto Superior de Agronomia of Universidade Técnica de Lisboa);
- Plastic association (Association of Plastics Manufacturers in Europe).

Besides these entities, an aluminium association was also contacted, but did not accept to cooperate in the review process.

The critical review of this life cycle analysis corresponds – in accordance with ISO 14040 – to an external expert and interested parties review.

The comments of the various members of the independent committee to the temporary version of this LCA report are presented in section VI, together with the corresponding response of PwC/Ecobilan.

SECTION III - Calculation of inventory: collection of data and calculation hypotheses

This section presents the data sources specific to the survey and the hypotheses adopted to calculate the LCA inventories. Only data and hypotheses relative to the primary stages such as production of the materials constituting the stoppers, production of the stoppers (only for cork stoppers), transport, bottling and end of life are detailed. Bibliographical data sources used to model secondary stages of the systems are listed in Appendix III.

10 Method of collecting information

To gather relevant information on the cork stoppers and identify available data sources, a questionnaire was sent to three of Corticeira Amorim's production units (cork treatment, cork stoppers production and cork stoppers finishing) requesting information on the following elements for each of the different types of stoppers:

- Weight;
- Dimensions;
- Composition;
- Manufacturing site;
- Manufacturing process;
- Main bottling centres in UK;
- Transport to bottling centres.

Regarding aluminium and plastic closures, part of the information was supplied by Corticeira Amorim and TEAM™ database, and, if not available, internet research was the method used for collecting information. In this survey we have not used information supplied by the producers of aluminium and plastic closures. Sections 15 and 17 present the modelling and data sources employed for the use and end of life of the closures.

Regarding cork stoppers, most of the data was obtained using actual data from Corticeira Amorim's industrial units. In the case of cork treatment, data used was supplied by Corticeira Amorim's unit in Coruche (Portugal). In the case of cork production and finishing, data used was supplied by Corticeira Amorim's units in Santa Maria de Lamas (Portugal).

For each phase of transportation by road Corticeira Amorim has indicated the type of truck used, and the characteristics of the transport (maximum load, actual load, average fuel consumption and rate of return empty).

11 Modelling of systems and inventory calculation tool

To model the systems and calculate the LCA inventories and environmental impacts, we used the TEAM™ software. TEAM™ is Ecobilan's tool for analysing product life cycles. TEAM™ allows the user to build up and manage large databases and model any system representing the different industrial operations relative to the products, processes and activities of a company.

12 Life cycle of cork stoppers

The data used to model the life cycle of cork stoppers is shown in table 3. The data describing the cork stoppers was collected from three Amorim & Irmãos units. The data sources used to model the various upstream life cycle stages of the stoppers are shown in table 4. Sections 15 and 17 present the modelling and data sources employed for the use and end of life of the stoppers.

Cork products and related activities are directly and indirectly associated to carbon sink, as explained next:

- The capture of carbon by the cork oaks during the photosynthesis process results in plant growth and transforms atmospheric CO_2 into O_2 and, in the case of organic matter, into cellulose. For this reason the forest is considered to be an important carbon sink. Considering that the exploitation of the cork oak forest is largely made possible by the activities of Corticeira Amorim, the positive impact on carbon capture of the oak forest could be indirectly attributed to Corticeira Amorim;
- Since 50% of cork is carbon, and considering that this carbon results from the fixation of CO_2 during photosynthesis process, it can be assumed that each cork stopper is responsible for a determined amount of CO_2 corresponding to the conversion of C into CO_2.

In this survey only the carbon sink associated to cork stoppers weight has been considered, since this is directly related to Corticeira Amorim's products.

However, in order to demonstrate the indirect positive impact on carbon capture of the oak forest corresponding to Corticeira Amorim's activities, a simulation of carbon sink using this hypothesis was performed and is presented in section 21.

	Consumption or emission (yearly value)	**NOTES**
CORK HARVESTING - input		
Carbon dioxide (carbon fixed in cork stoppers, sink effect)	19 710 755 kg	It was considered that 50% of cork is carbon, which comes from CO2 fixation. 50% * (12+2*16)/12 * Cork (raw) * 1000
CORK HARVESTING - output		
Cork (raw)	10 751 321 kg	This data concerns the extracted cork (dry cork) that goes to one cork treatment site (Coruche) in one year (2005 data)
CORK TREATMENT - upstream transport		
Cork treatment plant	Coruche, Portugal	-
Transportation of cork from the forestry to the raw material site	Distance: 150 km Actual Load: 9 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: Yes	-
Transportation of the chemical products from production sites	Distance (km): 70 (Sodium hydroxide); 240 (Coagulant), 2200 (Flocculant); 95 (Corrosion inhibitor) and 250 (Salt) Actual Load: 24 tonnes	-

	Consumption or emission (yearly value)	NOTES
	Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: 30%	
CORK TREATMENT - inputs		
Cork (raw)	10 751 321 kg	This data concerns the extracted cork (dry cork) that goes to one cork treatment site (Coruche) in one year (2005 data)
Cork (recycled)	-	Recycling of cork stoppers has not been taken into account since it is not significant.
Percentage of cork for natural stoppers in raw material site (in % of weight)	30%	Represents the percentage of treated cork used to produce natural stoppers
Chemical products used in the water treatment plant	Sodium hydroxide: 30 425 kg	Solution of sodium hydroxide (25% or 50% NaOH) - the worst scenario for Corticeira Amorim was assumed (50% concentration)
	Coagulant: 34 600 kg	It was considered the aluminium oxide module
	Flocculant: 34 800 kg	It was considered the aluminium oxide module
Chemical products used in the boiler	Corrosion inhibitor: 195 kg	It was considered 1/3 Caustic Soda, 1/3 Sodium Sulphate and 1/3 Sodium Carbonate
	Salt (NaCl): 1000 kg	-
Water consumption	15 060 m^3	-
Electricity consumption	143 157 kWh	-
Wood Consumption	4 250 kg	-
Propane gas consumption	52 031 kg	-
CORK TREATMENT - outputs		
Recovered Matter: cork waste (Used for Energy)	859 580 kg	Internal recovery
Air emissions	Carbon Dioxide (CO_2): 1 563 532 kg	Source: Report on empirical emissions from cork waste (CBE, 2008)
	Carbon Monoxide (CO): 8 235 kg	Source: Report of the air emission characterization (IDIT, 2006)
	Nitrogen Oxides (NO_x as NO_2): 17 017 kg	Source: Report on empirical emissions from cork waste (CBE, 2008)
	Particulates (unspecified): 1 040 kg	Source: Report of the air emission characterization (IDIT, 2006)
	Sulphur Oxides (SO_x as SO_2): 173 kg	Source: Report on empirical emissions from cork waste (CBE,

	Consumption or emission (yearly value)	**NOTES**
		2008)
	VOC (Volatile Organic Compounds): 66 kg	Source: Report of the air emission characterization (IDIT, 2006)
Water emissions	BOD5 (Biochemical Oxygen Demand): 2 108 kg	Source: Water quality monitoring report (Efacec Ambiente, 2006)
	COD (Chemical Oxygen Demand): 11 913 kg	
	Phenol (C6H5OH): 4 kg	
	Suspended matter: 1 774 kg	
Industrial waste (total)	173 200 kg	Sludges for agricultural use
NATURAL STOPPERS PRODUCTION – upstream transport		
Transportation of treated cork from: Coruche and Ponte de Sôr (two cork treatment plants); and other locations (Portugal)	Distance: 270km Actual Load: 12,18 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: No	-
Transportation of treated cork: from Spain	Distance: 400 km Actual Load: 12,18 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: No	-
Transportation of the chemical products from production sites	Distance (km): 280 (H2O2) ; 280 (Sodium hydroxide); 10 800 (Sulfamic acid); 300 (Corrosion inhibitor) and 20 (Salt) Actual Load: 24 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: 30%	-
NATURAL STOPPERS PRODUCTION – inputs		
Treated cork	Total treated cork: 7 723 694 kg	Origins of treated cork: Coruche (Portugal): 3 522 804 Kg Ponte de Sôr (Portugal): 3 627 930 kg Other locations (Portugal): 14 540 kg Imported (Spain): 558 420 kg
Chemical products used in the washing process	Hydrogen Peroxide (H_2O_2): 248 115 kg	-
	Hydrogen Peroxide (35%, H_2O_2): 3 315 kg	-
	Sodium Hydroxide (NaOH, 9%): 144 849 kg	-
	Sodium Hydroxide (NaOH, 0.08%): 276 420 kg	-
	Sulfamic acid: 244 647 kg	It was considered the sulphuric oxide module

	Consumption or emission (yearly value)	NOTES
Chemical products used in the boiler	Corrosion inhibitor: 910 kg	It was considered 1/3 Caustic Soda, 1/3 Sodium Sulphate and 1/3 Sodium Carbonate
	Salt (NaCl): 1825 kg	-
	Corrosion inhibitor: 450 kg	It was considered 1/3 Caustic Soda, 1/3 Sodium Sulphate and 1/3 Sodium Carbonate
Water consumption	14 771 m^3	-
Electricity consumption	6 435 396 kWh	-
Wood Consumption	49 300 kg	-
Natural gas consumption	99 538 m^3	-
Diesel oil consumption (forklift trucks consumption)	17 594 l	-
NATURAL STOPPERS PRODUCTION – output		
Recovered Matter: cork waste (Used for Energy)	769 000 kg	Internal waste used to provide energy to the site by incineration
Air emissions	Carbon Dioxide (CO_2): 1 481 123 kg	Source: Report on empirical emissions from cork waste (CBE, 2008)
	Carbon Monoxide (CO): 8 370 kg	Source: Report of the air emission characterization (IDIT, 2006)
	Nitrogen Oxides (NO_x as NO_2): 16 121 kg	Source: Report on empirical emissions from cork waste (CBE, 2008)
	Particulates (unspecified): 103 330 kg	Source: Report of the air emission characterization (IDIT, 2006)
	Sulphur Oxides (SO_x as SO_2): 164 kg	Source: Report on empirical emissions from cork waste (CBE, 2008)
	VOC (Volatile Organic Compounds): 70 kg	Source: Report of the air emission characterization (IDIT, 2006)
Water emissions	BOD_5 (Biochemical Oxygen Demand): 524 kg	Source: Water quality monitoring report (Efacec Ambiente, 2006)
	COD (Chemical Oxygen Demand): 3 643 kg	
	Phenol (C_6H_5OH): 29 kg	
	Suspended matter: 455 kg	
Waste (total)	293 940 kg	Mix of urban waste and equivalent Ashes Cork dust Waste to landfill
Recovered waste	1 571 080 kg	Metals and metal packages Paper and cardboard Sludges
NATURAL STOPPERS FINISHING – upstream transport		
Transportation of the chemical products from production sites	Distance (km): 2000 (Silicone elastomer); 2600 (Silicone emulsion); 2600 (Paraffin	-

	Consumption or emission (yearly value)	NOTES
	emulsion); 1000 (Silbione oil) Actual Load: 24 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: 30%	
NATURAL STOPPERS FINISHING - inputs		
Finished natural stoppers 45x24	440 013 000 units	Weight per stopper: 3,5 g
Chemical products used	Silicone elastomer: 769 kg	-
	Silicone emulsion: 150 kg	-
	Paraffin emulsion: 1 039 kg	-
	Silbione Oil: 466 kg	Silicone oil/ polydimethylsiloxane
Electricity consumption	81 300 kWh	-
Natural gas consumption	1 235 m^3	-
NATURAL STOPPERS FINISHING – outputs		
Finished natural stoppers 45x24	440 013 000 units	Weight per stopper: 3.5 g
Air emissions	Particulates (unspecified): 184 kg	Source: Report of the air emission characterization (IDIT, 2005)
Recovered Matter (paper and cardboard)	5 040 kg	
TRANSPORT of FINISHED STOPPERS – downstream		
Finished stoppers	2 080 000 units/truck	-
Transportation of the finished natural stoppers: from Portugal to UK (Bristol and Manchester - the 2 biggest bottling centres in UK)	Distance: 2 267 km (weighted average) Actual Load: 8,23 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: No	Stoppers are transported in big bags placed over wood pallets (whose weight is included in calculations)
BOTTLING IN UK – inputs		
Polyvinyl Chloride	1,06 g/stopper	-

Table 4: Information used to model the life cycle of cork stoppers

Unit process	Origin of data
Wood (55% dry - Modified for Corticeira Amorim): Supply	Forest cultivation and lumbering. Ecobilan and data.
Hydrogen peroxide (H_2O_2) production	Ecoprofile of Hydrogen Peroxide, I.Boustead and M.Fawer, Brussels, February 1998
Paraffin production	Tenside Surfactants Detergents, Journal for Theory, Technology and Application of Surfactants, Carl Hanser Verlag, Munchen, März/April 1995
Silicone rubber production	Average of American Chemical industries (survey) 1983

Unit process	Origin of data
Sodium Carbonate (Synthetic, Na_2CO_3) production	Reaction of calcium carbonate with sodium chloride. Stoichiometric data for consumed products
Sodium chloride (NaCl, Purified Brine) production	Eco-profiles of the European polymer industry (APME), Polyvinyl Chloride I.Boustead, Brussels, May 1998
Sodium Hydroxide (NaOH) production	Eco-profiles of the European plastics industry (APME), Polyvinyl Chloride, I.Boustead, Brussels, September 2002
Aluminium Oxide (Al_2O_3) production	Environmental Profile Report for the European aluminium Industry EAA (European Aluminium Association) April 2000
Sulphuric Acid (H_2SO_4) production	BUWAl 232 Band 2: Daten Vergleichende ökologische Bewertung von Anstrichstoffen im Baubereich Bern, 1995

Table 5: Sources of data used to model the upstream life cycle of cork stoppers

13 Life cycle of aluminium closures

The data used to model the life cycle of the aluminium wine closures considered on this survey is shown in table 5. The data sources used to model the various upstream life cycle stages of the closures are shown in table 6. Sections 15 and 17 present the modelling and data sources employed for the use and end of life of the closures.

In this survey we have only considered data available in the public domain.

	Consumption or emission (yearly value)	NOTES
ALUMINIUM PRODUCTION		
Aluminium production site	East of France	
Primary Aluminium	65%	Source: Association Francaise de l'Aluminium. Average for all types of aluminium uses.
Secondary Aluminium	35%	Source: Association Francaise de l'Aluminium. Average for all types of aluminium uses.
ALUMINIUM CLOSURES PRODUCTION		
Aluminium closures production site	East of France	
Aluminium closure 30x60	1 unit Dimension: 60 x 30 mm Weight: 4,562 g Composition: Aluminium – 89,9%; Expanded PET – 7%; Tin – 2%; Kraft – 0,5%; PVDC – 0,6%	-

	Consumption or emission (yearly value)	NOTES
Transportation of aluminium closures: from the aluminium production site to the aluminium closures production site	Distance: 300 Km Actual Load: default value, 24 tonnes Maximum Load: default value, 24 tonnes Consumption: default value, 35 l/100 km Empty Return: default value, 30%	-
Aluminium	4,562 g / closure	-
Polyethylene terephthalate (PET, film)	0,3193 g / stopper	-
Tinned plate	0,09124 g / closure	-
Polyvinylidene Chloride (PVdC)	0,0278 g / stopper	-
Kraftliner	0,02281 g / stopper	-
Paint (water based)	0,1 g / stopper	.
TRANSPORT		
Aluminium closures 30x60	998 400 units/truck	Calculation based on the volume of the aluminium stopper
Transportation of the aluminium closures: from France to UK	Distance: 1 042 km (weighted average) Actual Load: 5,5 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: No	Bristol and Manchester are the two biggest bottling centres in the UK It was assumed the same type of transport as in the transportation of the cork stoppers from Portugal to UK

Table 6: Information used to model the life cycle of aluminium closures

Unit process	Origin of data
Aluminium slab (Primary) production	EAA (European Aluminium Association), Environmental Profile Report for the European aluminium Industry, April 2000
Aluminium Slab (Secondary) production	European aluminium Association (EAA), Environment Profile Report for the European Aluminium Industry, April 2006
Polyethylene terephthalate (PET, Film) production	Eco-profiles of the European Plastics Industry, I.Boustead, Plastics Europe, Brussels, March 2005
Polyvinylidene chloride (PVdC-2005) production	Ecoprofiles of plastics and related intermediates, I.Boustead, APME, Brussels, March 2005
Tinned plate (100% recycled, based on steel scraps) production	BUWAL (Bundesamt für Umwelt, Wald und Landschaft) n°250, Bern, 1996
Kraftliner	European database for Corrugated Cardboard Life Cycle Studies, FEFCO 2006
Water-Borne Paint (Acrylic) production	Confidential site data (1996). Water based paint for indoor applications with 1,26 kg/l density.

Table 7: Sources of data used to model the upstream life cycle of aluminium closures

14 Life cycle of plastic closures

The data used to model the life cycle of the plastic wine closures considered on this survey is shown in table 7. The data sources used to model the various upstream life cycle stages of the closures are shown in table 8. Sections 15 and 17 present the modelling and data sources employed for the use and end of life of the closures.

In this survey we have only considered data available in the public domain.

	Consumption or emission (yearly value)	**NOTES**
PLASTIC CLOSURES PRODUCTION		
Plastic closures production site	Belgium	
Plastic closure 43x22	Dimension: 43 x 22 mm Density: 0,380 g/cm^3 Weight: 6,2 g Composition: Low Density Polyethylene: 68%; ½ High Density Polyethylene+ ½ Polypropylene: 32%	-
Transportation of plastics: from the production to the plastic closures production site (inside Belgium)	Distance: 300 km Actual Load: 24 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: 30%	-
Polyethylene (LDPE)	4,216 g / stopper	-
Polypropylene	0,992 g / stopper	-
High Density Polyethylene (HDPE)	0,992 g / stopper	-
TRANSPORT		
Plastic closures 43x22	2 590 505units/truck	Calculation based on the volume of the plastic stopper
Transportation of the plastic closures: from Belgium to UK	Distance: 725 km (weighted average) Actual Load: 17,01 tonnes Maximum Load: 24 tonnes Consumption: 35 l/ 100 km Empty Return: No	Bristol and Manchester are the two biggest bottling centres in UK It was assumed the same type of transport as in the transportation of the cork stoppers from Portugal to UK
BOTTLING IN UK		
Polyvinyl Chloride	1,06 g/closure	-

Table 8: Information used to model the life cycle of plastic closures

Unit process	**Origin of data**
Polyethylene (LDPE) production	Ecoprofiles of plastics and related intermediates, I.Boustead, PME, Brussels, March 2005

Polypropylene production (PP)	Ecoprofiles of the European plastics industry, Polyolefin, I.Boustead, APME, Brussels, July 2003
High Density Polyethylene (HDPE) production	Ecoprofiles of the European plastics industry, Polyolefin, I.Boustead, Plastics Europe, Brussels, March 2005
Polyvinyl chloride production	Ecoprofiles of the European plastics industry, PVC Conversion processes, I.Boustead APME, Brussels, October 2002

Table 9: Sources of data used to model the upstream life cycle of plastic closures

15 Modelling of use of wine closures

The phase of using the wine closures is assumed not to generate any significant impact attributable to the wine stopper.

16 Modelling of transportation of wine closures

The transport phases taken into account in the survey are as follows:

- transport of main materials to the closures production site, for cork, aluminium and plastic closures.
- transport of wine closures from the production sites to the bottling centres: Bristol (42%)and Manchester (58%) - the 2 biggest bottling centres in UK – a weighted average distance was considered, for each of the wine closures considered.

The other transport phases (e.g. Transport from the bottling sites to the shops, transport by consumers from the store to their house, transport of secondary materials involved in closures production: ink, pigments, adhesive, Collection phase of domestic waste after consumer use) are disregarded because their impact is low.

The transport distances considered in the modelling are shown in the above tables relative to each closure (Table 3, Table 5 and Table 7).

17 Modelling of the end of life of the closures

The end of life of wine closures is an important part of the survey and we have used a recognised modelling system, the WISARD™[5] software.

End of life procedures considered are presented in the table below.

	Stopper		
	Cork Stopper[6]	**Aluminium Stopper**[7]	**Plastic Stopper**[8]
Final destination of closure wastes	100% landfill	32% recycling 68% landfill	19% recycling 81% landfill

Table 10: End of life treatment considered (UK consumer market)

Although used cork stoppers are recyclable, there are only a few occasional initiatives to collect and recycle them and therefore in this survey we have not considered the recycling of used cork stoppers.

[5] WISARD: Waste Integrated Systems Assessment for Recycling and Disposal.
[6] Source: Corticeira Amorim
[7] DEFRA: Department for Environment, Food and Rural Affairs

1. Cork stopper in Controlled Landfill[8]

Regarding cork behaviour and technologies of landfill disposal, the main assumptions for the cork stopper end of life are:

- Time horizon: Methanogenic phase (100 years);
- Cork degradation is similar to wood profile with 0,05 kg of landfill gas (50% CH_4 + 50% CO_2) emitted per kg of wood;
- 5% of water present in the cork stopper (at the time of disposal);
- Covered landfill with 50% of landfill collected (minimum for UK landfills)[9]
- Presence of a system of treatment of the leachate[10]

2. Aluminium Closure Recycling

It was considered that used aluminium closures are collected and sorted and sent for recycling. An end of life similar to aluminium packages in the UK was assumed. The quantities recycled are assumed to be directly reused by the aluminium production sector.

Transport of used closures for recycling was not considered.

3. Plastic Closure Recycling

It was considered that used plastic closures are collected and sorted and sent for recycling. An end of life similar to plastic packages in the UK was assumed.

Regarding plastic stopper recycling it was considered that they are 100% recyclable.

Transport of used closures for recycling was not considered.

4. Aluminium and plastic closures in controlled landfill

Regarding technologies of landfill disposal, the main assumptions are:

- Covered landfill with 50% of landfill gas collected;
- Presence of a system of treatment of the leachate.

18 Hypotheses and sources of data concerning transport and production of electricity

18.1 Transport model

18.1.1 General calculation for the consumption of gas oil linked to transportation

In this survey, for each stage of transportation, the following data has been defined:

- Distance;
- Actual Load;
- Maximum Load;
- Consumption;
- Empty Return.

[8] *Life Cycle Assessment of a single-piece natural cork stopper for oenological use* p.16, ECOBILANCIO ITALIA
[9] Source: Environmental Agency of England and Wales

Assumptions made are presented in tables 4, 6 and 8.

To calculate actual consumption, it is assumed that part (2/3) is fixed and part (1/3) depends on the weight transported by the truck.

In this survey, the following formula has been used:

Actual consumption (in litres) =
Distance * Consumption /100 *[2/3 +1/3 * Actual Load/Maximum Load + Rate of Empty Return *2/3]

18.1.2 Data source

The data used to model the combustion of gas oil in a truck engine was taken from the database of the Energy Systems laboratory, ETH (Eidgenössische Technische Hochschule) Zurich, (1996).

18.2 Electricity production models

This survey relates to wine closures manufactured in Portugal, France and Belgium and intended for the UK market, and includes also transport of raw materials and consumables, as described earlier. Consequently, the electricity production models chosen are representative of the situation within these different origin countries.

In the case of the production of plastic granules used for the production of plastic closures, as the data chosen is representative of the European average, the electricity model corresponds to the mean situation in Europe. The characteristics of each model are detailed in the table below.

Source of energy	European average (2002) (%)	Portugal (2004) (%)	France (2002) (%)	Belgium (2000) (%)	Spain (2004) (%)	Netherlands (2000) (%)	Germany (2000) (%)	China (2002) (%)
Coal	30,75	32,95	4,48	15,4	24,50	25,22	25,06	76,95
Lignite	0	0	0	0	3,76	0	25,96	0
Gas from blast furnaces and coking plants	0	0	0	3,71	0	3,18	1,31	0,52
Heavy fuel	5,87	12,64	0,81	0,95	8,51	3,49	0,84	3,01
Natural gas	17,35	25,92	4,10	19,04	19,81	57,71	9,19	0,28
Nuclear energy	31,80	0	77,98	57,4	22,71	4,38	29,69	1,53
Non-thermal energy	12,11	24,27	11,91	2,04	17,86	1,36	1,78	17,55
Renewable energy[10]	2,12	4,21	0,63	1,45	2,43	4,66	6,18	0,15
TOTAL	100	100	100	100	100	100	100	
Loss of distribution	6,39	9,09	5,75	4,39	8,61	4,56	4,41	7,12

Table 11: Origin of electricity in the countries concerned by the survey

The data used for the distribution between electrical options and yields is taken from statistics representative for the years 2000, 2002 and 2004 prepared by the International Energy Agency (IEA). The data used to model each option comes from the Laboratorium für Energiesysteme [Energy Systems Laboratory], ETH (Eidgenössische Technische Hochschule) Zurich, 1996.

[10] Renewable energy (wind power, solar, biomass, geothermic…)

Influence of the electricity model on the results

Amongst the indicators adopted, the choice of electricity model influences mainly the emission of greenhouse effect gases, atmospheric acidification and VOC emissions

SECTION IV - Results

Preamble: unless otherwise stated, all the results shown and the following graphics relate to the functional unit adopted (section 5.1), namely, sealing one thousand standard bottles of wine bottled and sold on the UK market.

19 Limits of the survey

Before presenting the results, the limits of the survey are summarized below.

We collected data from Corticeira Amorim for the production of cork stoppers and used generic data to represent aluminium and plastic closures production, namely regarding raw materials consumed. The data referring aluminium and plastic closures does not include the production stage itself, due to lack of information. The impact of this limitation is the minimization of environmental impacts associated to these types of closures. This limitation also has to be taken into account when comparing environmental performances of the different closures, particularly in the comparison of the environmental performances of aluminium and plastic closures.

The precise composition of the aluminium and plastic closures was not available. Using public data from the producers of these corks, we identified the principal materials contained in the closures, as describe above.

20 Results from the wine closures analyzed per industrial stage

In this section we shall successively present the results obtained for each indicator by researching the life cycle stages with the most significant effect on the overall result.

20.1 Non-renewable energy consumption

Aluminium and plastic closures have significantly higher non-renewable energy consumption, when compared with cork stoppers (cork stoppers only represent 22% and 20% of the aluminium and plastic closures contribution to this impact, respectively). This is mainly due to energy consumed for the production of raw materials (aluminium and different types of plastic) used by aluminium and plastic closures.

Bottling represents for cork stoppers the major part of the energy consumed (68%).

The beneficial impact in terms of non-renewable energy consumption associated to plastic closures is due to the fact that in this survey we are considering a scenario of plastic recycling, meaning that there is a beneficial impact related to avoiding the production of virgin plastic granules.

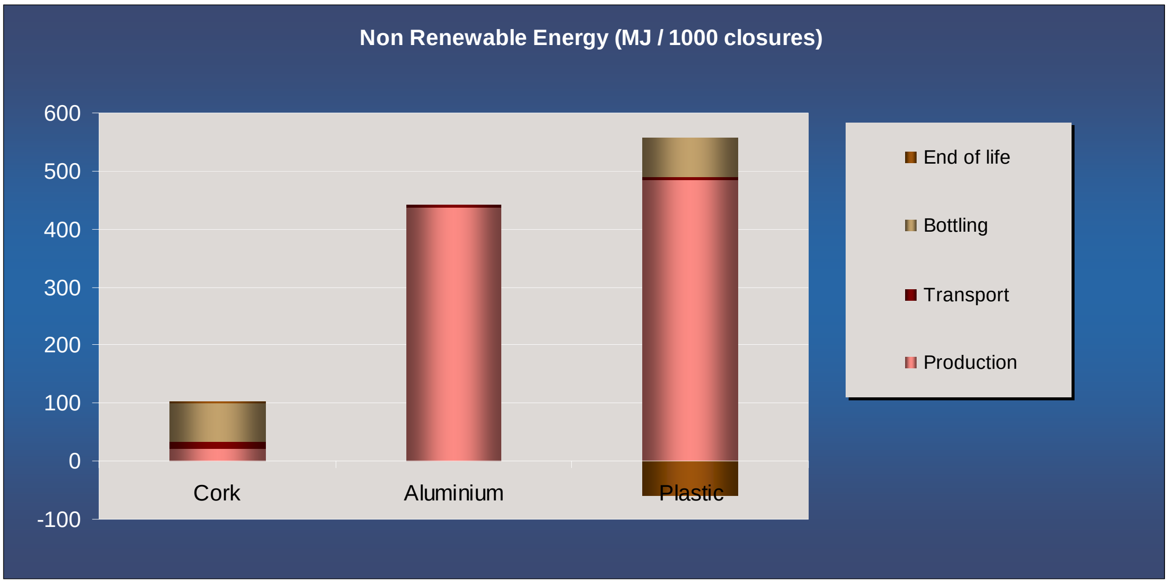

Figure 5: Consumption of non-renewable energy per stage of life cycle for the closures studied

20.2 Water consumption

Plastic closures show the biggest water consumption of all three closures. Water consumption in production phases is similar for cork and aluminium closures, and significantly higher for plastic closures (cork stoppers and aluminium closures represent 61% and 33% of the plastic closures contribution to this impact, respectively).

Water consumption associated to bottling in the case of cork and plastic closures results from high water consumption associated to the production of PVC (12 litres for 1kg of PVC) that is used for the PVC cover at the bottling stage.

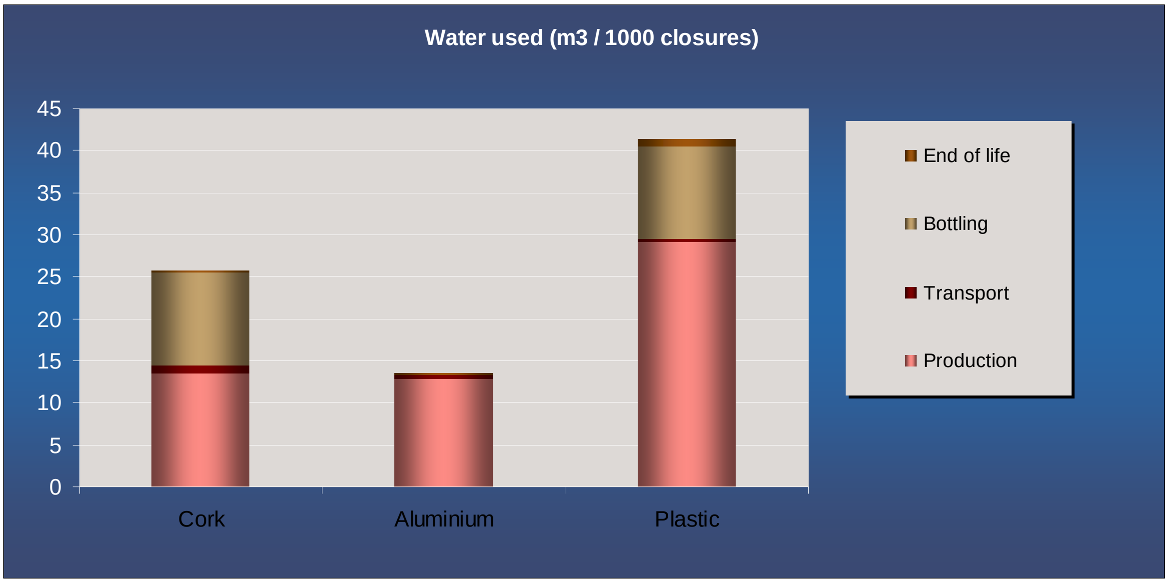

Figure 6: Consumption of water per stage of life cycle for the closures studied

20.3 Emission of greenhouse effect gases

Aluminium closures are associated to the highest greenhouse effect gases emissions, followed by plastic closures. Emissions associated to cork stoppers are significantly lower (cork stoppers only represent 4% and 10% of the aluminium and plastic closures contribution to this impact, respectively).

Bottling represents for cork stoppers a major part of the greenhouse effect gases emissions.

The beneficial impact in terms of emission of greenhouse effect gases associated to plastic closures is due to the avoidance of production of virgin plastic as a consequence of plastic recycling.

The beneficial impact in terms of emission of greenhouse effect gases associated to cork stoppers is due to the carbon intake during cork growth.

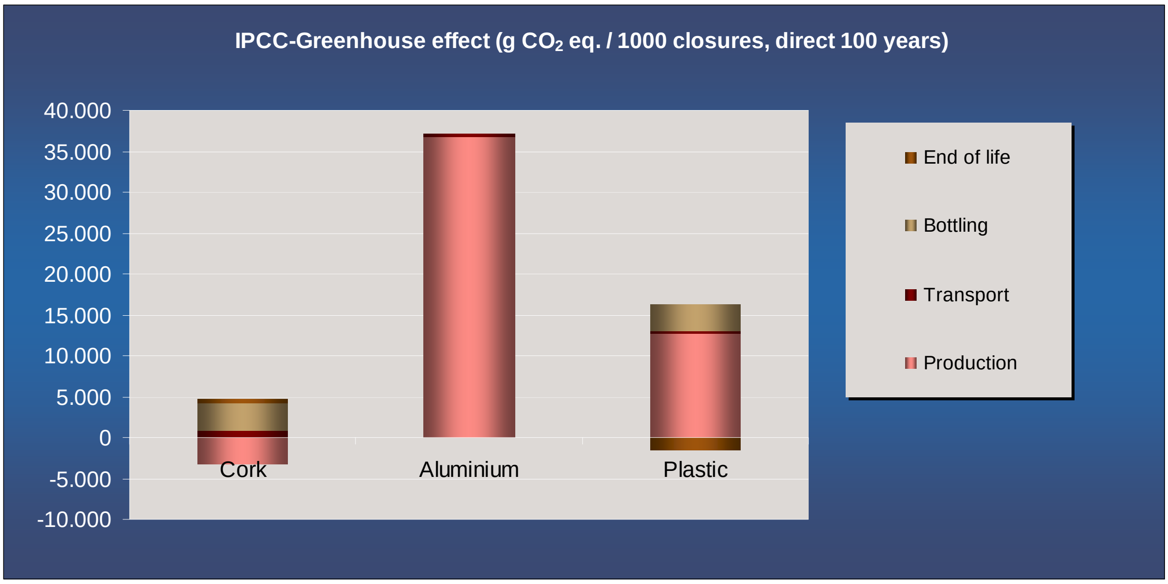

Figure 7: Emissions of greenhouse effect gases per stage of life cycle by the closures studied

20.4 Contribution to atmospheric acidification

From the analysed materials, aluminium closures are the biggest contributors to atmospheric acidification, followed by plastic closures and by cork stoppers. Contribution from cork is 15% and 61% of the aluminium and plastic closures contribution to this impact, respectively.

Bottling represents for cork stoppers the major part of contribution to atmospheric acidification (more than 35%).

The beneficial impact in terms of atmospheric acidification associated to plastic closures is due to the avoidance of production of virgin plastic as a consequence of plastic recycling.

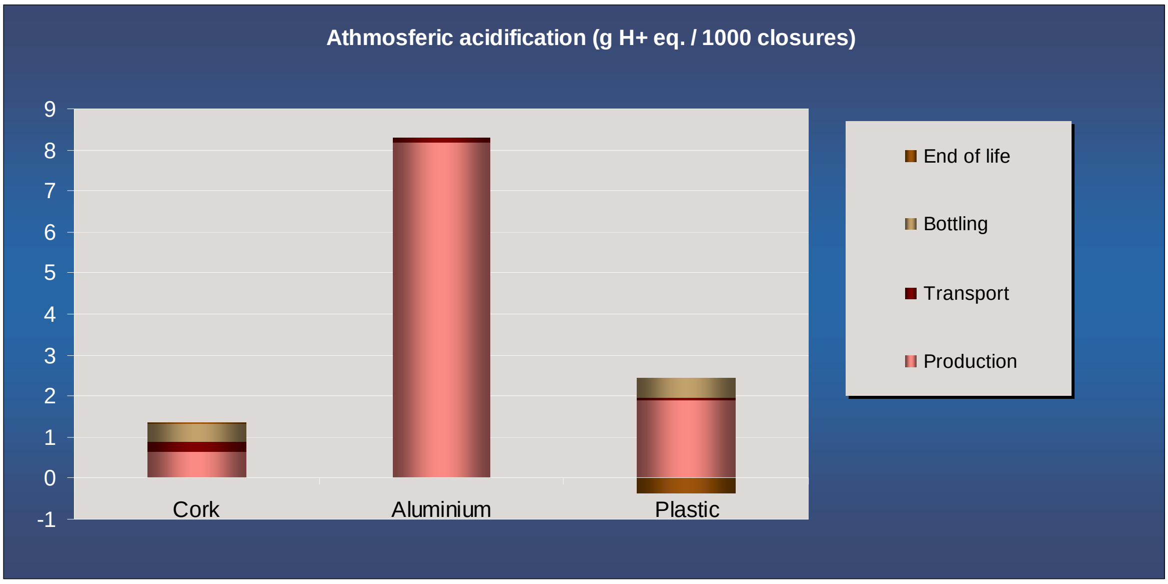

Figure 8: Contribution to atmospheric acidification per stage of life cycle for the closures studied

20.5 Contribution to the formation of photochemical oxidants

From the analysed materials, aluminium closures are the biggest contributors to the formation of photochemical oxidants, followed by plastic closures and by cork stoppers. Cork and plastic closures represents 24% and 67% of the aluminium closures contribution to this impact, respectively.

Transportation represents for cork stoppers the major part of the contribution to the formation of photochemical oxidants (more than 35%).

The beneficial impact in terms of formation of photochemical oxidants associated to plastic closures is due to the avoidance of production of virgin plastic as a consequence of plastic recycling.

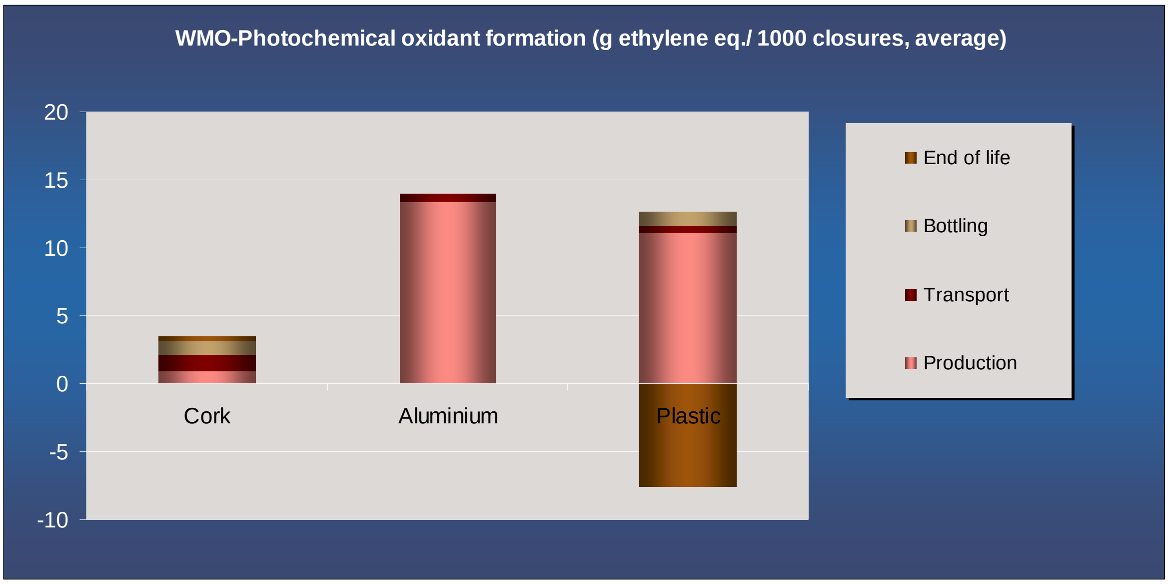

Figure 9: Formation of photochemical oxidants per stage of life cycle for the closures studied

20.6 Contribution to the eutrophication of surface water

Plastic closures are the biggest contributors to water eutrophication, followed by plastic and cork closures. Contribution from cork is 91% and 66% of the aluminium and plastic closures contribution to this impact, respectively.

Production phase is for the aluminium closures, the most relevant in term of contribution to the eutrophication of water (representing 96%).

Bottling phase is for the cork and plastic closures the most relevant in term of contribution to the eutrophication of water (representing for cork and plastic 72%).

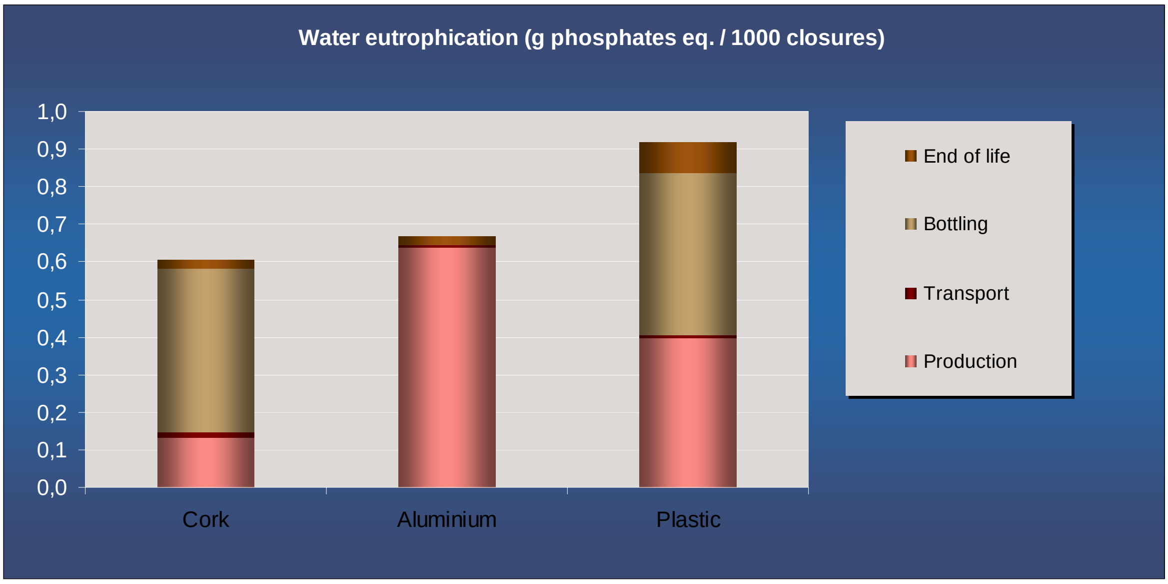

Figure 10: Contribution to eutrophication per stage of life cycle by the closures studied

20.7 Total production of solid waste

Aluminium closures are the biggest producers of solid waste, followed by plastic and cork closures. Contribution from cork is 50% and 63% of the aluminium and plastic closures contribution to this impact, respectively.

In the case of aluminium closures, production phase and end of life are the phases responsible for the major production of solid waste. When compared with cork and plastic closures, production of waste at the production phase in the case of aluminium is significantly higher.

In the case of cork and plastic closures, post-consumer end of life phase is the most relevant in term of production of solid waste, while the rest of the phases are not relevant, representing 10% of total wastes produced.

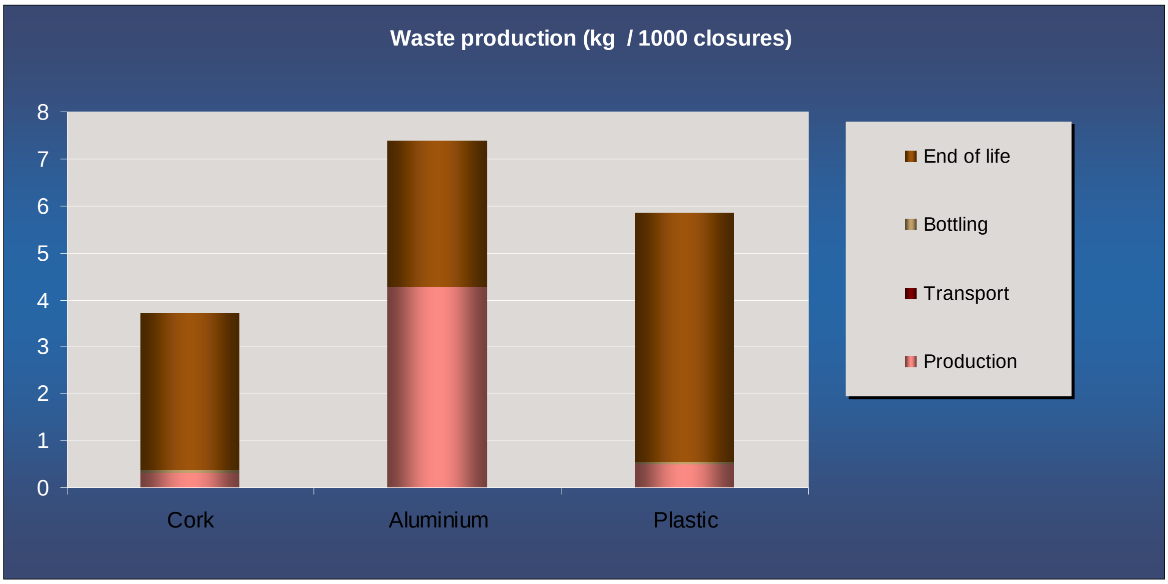

Figure 11: Production of solid waste per stage of life cycle by the closures studied

20.8 Summary of the relative performances of the closures

The relative performances of the different closures studied are summarised in the table below, where differences are expressed as a relation to closure with the best performance:

Environmental Indicator	Type of stopper		
	Cork Stopper	Aluminium Stopper	Plastic Stopper
Non-renewable energy consumption	1.00	4.46	5.00
Water consumption	1.88	1.00	3.07
Emission of greenhouse gases	1.00	25.84	10.23
Contribution to atmospheric acidification	1.00	6.61	1.63
Contribution to the formation of photochemical oxidants	1.00	4.22	1.49
Contribution to the eutrophication of surface water	1.00	1.10	1.52
Production of solid waste	1.00	1.99	1.58

Table 12: Relative performances of the different closures studied

Key:
- Best Performance
- Performance poorer by less that 20 % in relation to best performance
- Performance poorer by at least 20 % in relation to best performance

Differences in the system studied and exclusions described in sections 6.1 and 6.2 of this report have to be taken in account when comparing environmental performances of the different closures. Considering that in this survey we adopted always the worse scenario for cork stoppers, this remark is mainly applicable for the comparison of the environmental performances of aluminium and plastic closures.

21 Sensitivity analyses and simulations

In order to test the strength of the preceding observations, several variations of the basic scenario were considered.

21.1 Composition of plastic closures

Context: Exact composition of plastic closures is unknown. According to available information plastic closures are composed by 68% of Low Density Polyethylene (LDPE), and the remaining 32% are a mixture of High Density Polyethylene (HDPE) and Polypropylene (PP).

Hypotheses: It is important to know how environmental performances will change depending on the composition. Therefore, a sensitivity analysis was performed, considering three hypotheses for the composition of plastic closures:

- 68% Low Density Polyethylene (LDPE); 16% High Density Polyethylene (HDPE); 16% Polypropylene (PP);
- 68% Low Density Polyethylene (LDPE); 32% High Density Polyethylene (HDPE);
- 68% Low Density Polyethylene (LDPE); 32% Polypropylene (PP).

Results: The relative performances of the different options considered are summarised in the table below, where differences are expressed as a relation to closure with the best performance:

Environmental Indicator	Composition of plastic closures		
	68% LDPE 16% HDPE 16% PP	**68% LDPE 32% HDPE**	**68% LDPE 32% PP**
Non-renewable energy consumption	1.00	1.01	1.00
Water consumption	1.04	1.00	1.07
Emission of greenhouse gases	1.00	1.00	1.01
Contribution to atmospheric acidification	1.00	1.01	1.00
Contribution to the formation of photochemical oxidants	1.05	1.10	1.00
Contribution to the eutrophication of surface water	1.50	1.00	1.99
Production of solid waste	1.00	1.00	1.00

Table 13: Relative performances for different compositions of plastic closures

Key:

Best performance

Performance poorer by less that 5 % in relation to best performance

Performance poorer by at least 5 % in relation to best performance

As described in the previous table, environmental performances are very similar for all indicators analysed, except for eutrophication of surface water.

These results allow to conclude that:

- If the content of PP is higher that what was considered, the environmental impacts will be more significant, for the following indicators: Contribution to the eutrophication of surface water and water consumption;
- If the content of HDPE is higher that what was considered, the environmental impacts will be more significant in terms of Contribution to the formation of photochemical oxidant.

Considering that the results achieved are very similar for the 3 scenarios analysed and since the exact composition of plastic closures is unknown, in this survey the intermediate situation was considered: 68% Low Density Polyethylene (LDPE); 16% High Density Polyethylene (HDPE); 16% Polypropylene (PP).

21.2 Cork behaviour in landfill

Context: After use in the UK, cork stoppers are sent to landfills with the rest of the domestic waste. Since cork behaviour in landfill is not known, it was assumed the same conditions as for wood and different landfill gas production scenarios were considered.

Hypotheses: The two different condition for landfill gas production considered were: 0,05 kg/kg product and 0,15 kg/kg product.

Results: The relative performances of the different scenarios considered are summarised in the table below, where differences are expressed as a relation to stopper with the best performance:

Environmental Indicator	Cork behaviour in landfill	
	0,05 kg landfill gas/ kg product	0,15 kg landfill gas/ kg product
Emission of greenhouse gases	1.00	1.70
Contribution to atmospheric acidification	1.00	1.00
Contribution to the formation of photochemical oxidants	1.00	1.14

Table 14: Relative performances for cork behaviour in landfill scenarios considered

Key:
- (light green) Best Performance
- (dark green) Performance poorer by less that 20 % in relation to best performance
- (red) Performance poorer by at least 20 % in relation to best performance

21.3 Carbon sink associated to cork forestry

Context: Cork products and related activities are indirectly associated to carbon sink by the cork tree forestry. Considering that the exploitation of the cork oak forest is largely made possible by the activities of Corticeira Amorim, the positive impact on carbon capture of the oak forest could be indirectly attributed to Corticeira Amorim.

Hypotheses: The capture of carbon by the cork oaks during the photosynthesis process results in plant growth and transforms atmospheric CO_2 into O_2 and, in the case of organic matter, into cellulose. For this reason the forest is considered to be an important carbon sink.

The calculation of this carbon sink was based on a study carried out in Portugal by the Portuguese School of Agronomy (ISA)[11] that intended to measure the annual sequestration of carbon, through the Net Ecosystem Production (NEP) (results: 179 g C/m^2 in 2006 for a Portuguese cork oak forest close to Évora). Using this value, it was estimated the total amount

[11] Pereira, J. S., Correia, A.P., Mateus, J.A., Aires, L.M.I., Pita, G., Pio, C., Andrade, V., Banza, J., David, T.S., Rodrigues, A., David, J.S., *O sequestro de carbono por diferentes ecossistemas do Sul de Portugal* (*Carbon sink from several ecossystem of the south of Portugal*)

of carbon sink corresponding to the cork oak forest and to each kg of cork.

Results: The graphic below presents the impact of considering the carbon sink associated to forestry. This calculation was not made under TEAM™ software, it adds to the results of TEAM™ the carbon sink of the forest based on the assumptions previously described.

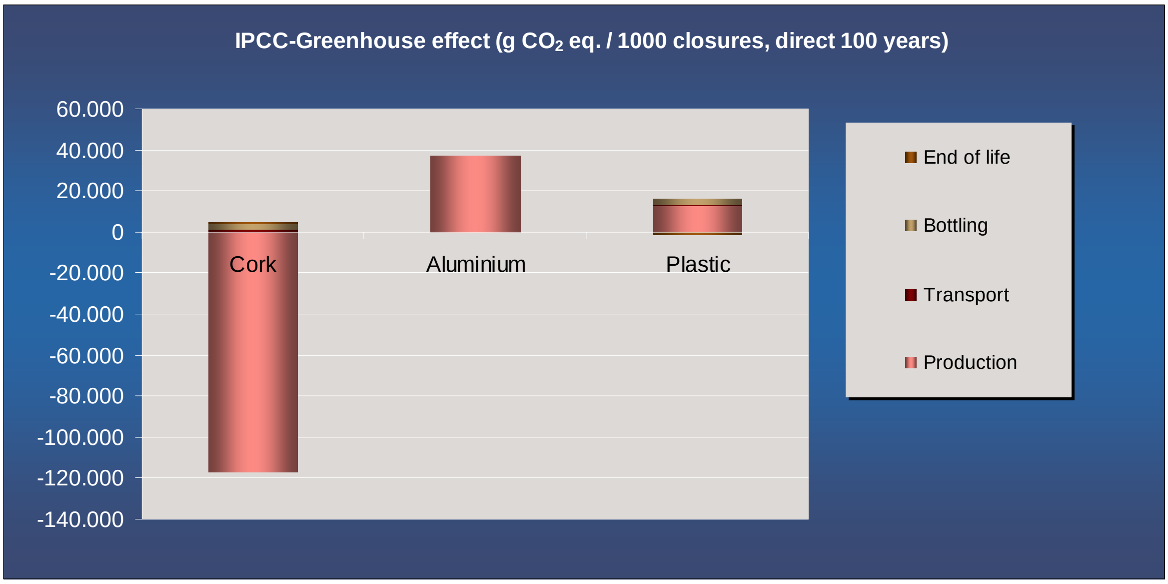

Figure 12: Emissions of greenhouse effect gases per stage of life cycle by the closures studied considering the carbon sink associated to the cork oak forest

21.4 Impact of plastic closures recycling

Context: The recycling of plastic closures results in beneficial impact for some of the studied indicators, corresponding to the avoidance of production of virgin plastic and associated adverse impacts. Avoided impacts were considered because there is no incorporation of recycled plastic in the production of plastic closures (due to food safety and hygiene requirements).

Hypotheses: To test the sensitivity of the assumption concerning the limits of the system, it is important to analyse the importance of these avoided impacts, as compared to the impacts associated with the rest of the phases of the life cycle of plastic closures.

Results: The table below summarizes the main indicators used by TEAM™ where there is a significant advantage associated to avoided impacts resulting from recycling, at the level of consumption and emissions.

The relation between avoided impacts from the end of life phase and impacts associated to the rest of the life cycle phases of plastic closures was calculated for each of these indicators, in order to evaluate the sensitivity of the inclusion of the recycling in the plastic LCA system.

The scenario adopted in the comparisons was the one that presented best environmental performance for all the indicators considered, corresponding to the worse scenario for cork stoppers.

Environmental Indicator	Relevance (%)
Consumptions	
Natural Gas (in ground)	15
Oil (in ground)	12
Water	40
Feedstock Energy	13
Fuel Energy	7
Non Renewable Energy	11
Total Primary Energy	10
Emissions	
Air: Carbon Dioxide (CO2, fossil)	12
Air: Hydrocarbons (unspecified)	71
Air: Nitrogen Oxides (NOx as NO2)	24
Air: Sulphur Oxides (SOx as SO2)	10
Air: Particulates (unspecified)	858
Water: Acids (H+)	146
Water: Hydrocarbons	330
Water: Metals	266
Water: Nitrogenous Matter (as N)	10
Waste: Hazardous	25
Waste: Non Toxic Chemicals	21

Table 15: Relative importance of plastic closures recycling as compared to the rest of the LCA of plastic closures

Whenever the contribution from the avoided impacts is superior to the impacts of plastic closures, the percentage is above 100. The assumption is quite sensitive for some air (hydrocarbons, particulates) and water (hydrocarbons, metals) emissions.

21.5 Impact of aluminium closures recycling

Context: In this survey, impacts of aluminium closures through their entire life cycle include impacts resulting from aluminium recycling. The beneficial impact associated to recycling is included in the model through the introduction of recycled aluminium as a secondary material for food packaging products.

Hypotheses: To test the sensitivity of the assumption concerning the limits of the system, it is important to analyse the importance of these avoided impacts, as compared to impacts associated with the rest of the phases of the life cycle of aluminium closures.

Results: The table below summarizes, for the environmental indicators considered in this survey, the relative differences achieved if avoided impacts were considered.

The scenario adopted in the comparisons was the one that presented best environmental performance for all the indicators considered, corresponding to the worse scenario for cork closures.

Environmental Indicator	Aluminium closure	
	Without impact avoided	With impact avoided
Non-renewable energy consumption	1.49	1.00
Water consumption	1.01	1.00
Emission of greenhouse gases	1.58	1.00
Contribution to atmospheric acidification	1.66	1.00
Contribution to the formation of photochemical oxidants	1.50	1.00
Contribution to the eutrophication of surface water	1.61	1.00
Production of solid waste	1.29	1.00

Table 16: Relative performances for aluminium closures recycling

21.6 Impact of NOx on eutrophication

Context: NOx emissions have an indirect impact on the acceleration of eutrophication process, since part of nitrogen emited to the air (NOx) can be dissolved in the water, contributing for an increase in nitrogen loading of water bodies. The method used in this survey to evaluate environmental impacts on eutrophication only considers eutrophication due to direct water releases.

Hypotheses: To test the sensitivity of not including NOx emissions on eutrophication model used, a sensitivity analysis can be done. To transform air NOx into eutrophication equivalent (g. phosphate equivalent), NOx emissions are multiplied by 0,13.

Results: The table below summarizes the results achieved when considering contribution of NOx to Eutrophication.

Water eutrophication (g phosphates eq./1000 closures)	Cork stoppers	Aluminium closures	Plastic closures
Without NOx	0,60	0,67	0,92
With NOx	5,02	11,40	4,66

Table 17: Impact of NOx on eutrophication

According to the results below and considering that the test made leads to an overestimation of the importance of NOx due to the assumption that 100% of NOx ends up in water, it can be concluded that cork and plastic stoppers have similar performances (performances are within the 10% neutral zone around the best performing system).

SECTION V - Conclusions

22 Results relative to the contribution of industrial stages for each closure studied

The production phase predominates for all the indicators considered (except for solid waste production, where end of life phase predominates).

Using the LCA indicators selected in the report, environmental impact associated to the production phase is significantly higher for aluminium and plastic than for cork closures, for all the studied indicators. This is due to the high impact of production of aluminium and plastic, when compared with cork.

In terms of improving the performance of these two types of closures (aluminium and plastic), this means that a reduction in the unit weight of a closure (whilst maintaining its technical properties) will be the main alternative for the improvement of their environmental behaviour.

Bottling has similar impact for cork and plastic closures, since the bottling processes are identical. In the case of cork stoppers, this is the phase of the life cycle with the highest environmental impacts, mainly associated to the PVC cover.

Although most representative in the case of cork stoppers, since the stoppers are transported from Portugal to the UK (aluminium closures come from France and plastic closures from Belgium), whatever the closure considered, transport has a minor impact in the total emissions of closures, when comparing with other phases (namely production and bottling).

Regarding the end of life stage, the recycling of plastic closures results in beneficial impact for some of the studied indicators, corresponding to the avoidance of production of virgin plastic and associated adverse impacts. In the case of aluminium, this beneficial impact is included in the model through the introduction of recycled aluminium as a secondary material for food packaging products (in the case of plastic this is currently not possible due to food safety and hygiene requirements).

23 Comparative environmental appraisal of the three types of closures

The comparison of the environmental impacts of the three types of closures was carried out on the basis of an identical service rendered: sealing one thousand bottles of 0.75 litter of wine, i.e. the typical unit of wine packaging purchased, sold on the UK market.

This comparison was affected by:

- The context of aluminium recycling in France;
- Synthetic (aluminium and plastic) closures production data is not publicly available; the present study has not taken into account production data. Only production of the intermediary materials is included. This assumption disfavours cork;
- Bottling of wine is assumed to be performed in the UK in order to simplify the modeling. This assumption is common to the three types of closures (cork, aluminium and plastic).

These differences and other exclusions described at the report have to be taken in account when comparing environmental performances of the different closures. Considering that in this survey we adopted always the worse scenario for cork stoppers, this remark is mainly applicable for the comparison of the environmental performances of aluminium and plastic closures.

In this context, the main results of this comparison are:

- In comparison to the aluminium and plastic closures, the cork stopper is the best alternative in terms of non-renewable energy consumption, emission of greenhouse effect gases, contribution to atmospheric acidification, contribution to the formation of photochemical oxidants, contribution to the eutrophication of surface water and total production of solid waste;
- In comparison to the cork and plastic closures, the aluminium closure is the best alternative in terms of consumption of water, followed by cork stoppers.

Environmental Indicator	Type of stopper		
	Cork Stopper	Aluminium Stopper	Plastic Stopper
Non-renewable energy consumption	1.00	4.46	5.00
Water consumption	1.88	1.00	3.07
Emission of greenhouse gases	1.00	25.84	10.23
Contribution to atmospheric acidification	1.00	6.61	1.63
Contribution to the formation of photochemical oxidants	1.00	4.22	1.49
Contribution to the eutrophication of surface water	1.00	1.10	1.52
Production of solid waste	1.00	1.99	1.58

Table 18: Relative performances of the different closures studied

Key:

Best Performance

Performance poorer by less that 20 % in relation to best performance

Performance poorer by at least 20 % in relation to best performance

In conclusion, for the market and packaging application considered, cork stoppers is therefore better than the aluminium and plastic closures for all indicators, except for water consumption, which is the only weakness of this stopper.

24 Sensitivity analyses and simulations

In order to test the strength of the preceding observations, several variations of the basic scenario were considered (additional information supplied in chapter 21):

- **Composition of plastic closures:** Variation of the percentage of High Density Polyethylene (HDPE) and Polypropylene (PP). The following options were considered:
    - 68% Low Density Polyethylene (LDPE); 16% High Density Polyethylene (HDPE); 16% Polypropylene (PP);
    - 68% Low Density Polyethylene (LDPE); 32% High Density Polyethylene (HDPE);
    - 68% Low Density Polyethylene (LDPE); 32% Polypropylene (PP).
- **Cork behaviour in landfill:** Profile of the cork stopper with a different amount of landfill gas produced (0,05 kg gas/kg product and 0,15 kg gas/kg product);
- **Carbon sink associated to cork forestry:** Analysis of emissions of greenhouse effect gases considering the carbon sink associated to the cork oak forest, indirectly associated to Corticeira Amorim's activities;

- **Impact of plastic closures recycling:** Analysis of the importance of avoided impacts associated to recycling, when compared with the impacts associated with the rest of the phases of the life cycle of plastic closures;
- **Impact of aluminium closures recycling:** Analysis of the importance of avoided impacts associated to recycling, when compared with the impacts associated with the rest of the phases of the life cycle of aluminium closures.

Generally speaking, these variants did not significantly modify the previous observations with regard to the position of cork stoppers in relation to the aluminium and plastic closures. In this survey we adopted always the worse scenario for cork stoppers.

SECTION VI - Peer review

The comments presented in the following pages result from the critical review of the temporary version of the report from February of 2008by, performed by an independent committee including external experts and interested parties:

- An independent life cycle analysis (LCA) expert (Mr. Yvan Liziard);
- An independent specialist on cork (Mr. João Santos Pereira, from Instituto Superior de Agronomia of Universidade Técnica de Lisboa);
- Plastic association (Association of Plastics Manufacturers in Europe).

Besides these entities, an aluminium association was also contacted, but did not accept to cooperate in the review process.

The comments of the various members of the independent committee to the temporary version of this LCA report are presented in section VI, together with the corresponding response of PwC/Ecobilan.

25 Comments made by independent life cycle analysis (LCA) expert and PwC/Ecobilan's responses

General comments

The general opinion on the report is rather positive.
The study is globally clear, the global conclusions seem good.

Methodology, conformity to standards requirements

- Summary

Comment:
Chapter 3 in the composition of plastic closures, the 3rd option considered should be 32% for the Polypropylene (instead of 16%).
PwC/Ecobilan's response:
LCA report was reviewed accordance with this recommendation.

Comment:
The position took on the end of life of aluminium is questionable.
It seems wrong not to consider the recycling of aluminium in end of life because of the potential amount of recycled aluminium in the production of the closure. It is not a recycling in close loop. If really the recycled aluminium content of the closure is the same that the average content of the French aluminium production, the recycled aluminium is coming from other sources than the closures. This is taken into account in the inventory of the production of the aluminium. If the closures are recycled, even in UK, this amount of aluminium will replace primary aluminium somewhere with a positive impact on the environment.
Recycling of aluminium must be took into account.
PwC/Ecobilan's response:
The way the modelling was proposed was the following:

- The recycling of post consumer waste is taken into account through a reduction of waste treatment and the inclusion of the recycling stages until the entry into a recycling stock ("usable products leaving the system").
- A balance is then performed between usable products leaving the system (UL) and usable products entering the system (UE).
  - If UL>UE, a credit corresponding to the production of UL-UE kg of virgin products is considered for the stopper. This is the case for plastic stoppers.
  - If UL<UE, a debit corresponding to the production of UE-UL kg of virgin products is considered for the stopper.
  - If UL=UE, no further action is taken. This is the case for aluminium.

These allocation procedures between the successive uses of recycled materials are consistent with ISO14044, §4342 Allocation procedure: "Allocation procedures shall be uniformly applied to similar inputs and outputs of the system under consideration. For example, if allocation is made to usable products (e.g. intermediate or discarded products) leaving the system, then the allocation procedure shall be similar to the allocation procedure used for such products entering the system."

➢ Boundaries of the systems studied

Comment:
There is no explanation concerning the grey boxes of the flow charts.
PwC/Ecobilan's response: Grey boxes represent steps that were not included on the models studied, as referred on the page 14 of the temporary report. In order to make this information more explicit, a note on this issue was included next to Figures 2, 3 and 4 of the report.

Comment:
All the systems studied are not the same (with or without ink, production process included or not, transport included for some products and not for others…). A sensitivity analysis should be done based of different assumptions including for transport.
PwC/Ecobilan's response:
In order to reduce the differences between systems studied, some changes have been introduced at the LCA model and report, namely:

- Regading ink, it was only considered as part of the stopper in the case of aluminium stoppers (cover of the aluminium stopper), since it is essential for its use. Ink associated to branding is not part of the functional unit and is not considered in this study for any of the stoppers studied;
- Regarding transport, LCA model was reviewed in accordance with this recommendation and some transport steps missing were included. In the final version of the model and report we have included transport of chemicals used for production of cork stoppers, as well as transport of plastic granules for the production of plastic stoppers.

Diferences between the systems studied are clearly identified on §6.1 and §6.2 of the report. In addition, we have included at the report specific notes on the consideration of existent diferences when comparing performances of the different closures were included on §20.

Comment:
Even if the inventory of production process of the specific closure in aluminium and plastic are not available, it could be interesting to consider another production not too far of the production of the closures (packaging based on sheet of aluminium, or extruded polyolefins)
PwC/Ecobilan's response:
As referred on the report, in the absence of complete information on these steps, worst case scenario was always adopted for cork, and these steps were not included on the model

Comment:
In the cork treatment, it could be interesting to explain how are treated the organic volatile compounds.
PwC/Ecobilan's response:
As referred at the LCA report, after seasoning, cork is boiled to remove organic solids and to bring it to the correct moisture content for processing (13-14 per cent relative humidity). This is performed in closed steel tanks fitted with a special device known as CONVEX® that continuously traps and removes volatile organics such as trichloroanisole (TCA) from the washing water. VOC emissions from cork treatment are within the legal limits established, thus not requiring any additional treatment.

Comment:
§ 6.1.1 For bottling with cork stoppers, the inclusion of PVC is included. Is the ink used for printing included in the study? Even if there is a lack of information it is always better to take into account the impacts even if they are based on an other process than not to consider the problem.
PwC/Ecobilan's response:
As referred above, ink associated to branding is not part of the functional unit and is not considered in this study for any of the stoppers studied. In the case of cork stoppers, this would leed to a negligible impact, since is represent less than 0,02% of cork stoppers.

Comment:
§ 6.1.3 In the life cycle of plastic closure, what are the use of sand and wood?
PwC/Ecobilan's response:
This sentence was re-written, the sentence now refers PVC, tin plate, kraftliner and PET used for the production of plastic closures.

Comment:
§ 6.2.1 regarding the final destination of waste why are the wastes of the cork stoppers process not included?
PwC/Ecobilan's response:
Waste is less than 1% so was neglected as compared to 100% of post consumer waste stopper sent to landfill. Moreover, around 15% of the cork production is used as fuel (in boilers) and was hence treated as a co-product, with no energy credit for cork stopper (again, not quite favourable for cork).

Comment:
§ 6.2.2 Some information to prove that impacts are negligible should be given.
PwC/Ecobilan's response:
In order to demonstrate that its impact is negligible, an estimation of emissions associated to transport of workers for cork stripping was performed and included at §6.2.2.

Comment:
§ 6.3 Fig 4: 30 % of the cork harvested is used for stoppers. Those 30 % are treated in the stoppers production process. 32,5% are producing natural stoppers. What is the sense of the box with 35 %? Is it 35 % of the 32,5% which are stoppers 45x24 ? This should be clarified.
PwC/Ecobilan's response:
The Figure representing the distribution and use of cork was corrected. For further understanding of the process, an interpretation of the Figure was included.

Comment:
§ 6.3 Concerning the allocation, the modelling method is equivalent to a mass allocation.
An allocation by economic value seems more appropriate than a mass allocation.
PwC/Ecobilan's response:

The production of natural stoppers 45x24 consists only of general steps, through which all treated cork goes, it is possible to use a mass allocation in this model, thus preventing using formulas to allocate the different flows to the studied product. The LCA report was re-writen in order to fully clarify on the non-aplicability of mass allocation.

➢ Environmental flows

Comment:
§ 7.2: The indicator Eutrophication normally contains a contribution of nitrogen oxides. It is not clear why specifically NOx is not taken into account in Eutrophication in this study. Without a proper explanation, if this exists, this is not allowed, especially because NOx is often the biggest contributor. Allowing exclusion of specific factors might lead to incorrect conclusions. The category eutrophication should take into account atmospheric emissions.

PwC/Ecobilan's response:
Altough we only consider eutrophication due to direct water releases, we aknowledge that NOx emissions have an indirect impact on eutrophication. However, the inclusion of this impact may lead to an overestimation of the Eutrophication indicator, since only part of NOx finally ends up in water. In order to evaluate the possible impact of including NOx, a sensitivity analysis was performed, as results are presented in §21.

Comment:
Among all the indicators, some are robust (Greenhouse effect) and others less (photochemicals oxidants). It could be interesting to give some additional information concerning this aspect.

PwC/Ecobilan's response:
In order to supply this information, an additional column "robutness of the indicator", was included in Table 3 of the report.

Comment:
§ 7.2 The proposed impact categories are consistent with the goal of the study.
But impact categories choice should be more justified and discussed (why do they represent specific indicators for the products studied ?); justify the omission of some impact categories: area use, biodiversity…The LCA report can be completed on this issue, including information on similar studies

PwC/Ecobilan's response:
Criteria used for the selection of studied indicators is presented in §7. In order to further clarify this issue, some additional remarks have been added to this section of the report.

➢ Requirements relative to the quality of data

Comment:
A requirement of ISO 14044 is to do «an evaluation of the significance of the differences found»

PwC/Ecobilan's response:
Regarding the interpretation of results and in order to analyse differences in results between stoppers we propose Table 12, with a differential scale as compared to the best stopper. In order to allow a better evaluation of the significance of the differences found the differential scale used was chaged, and not outstands diferences inferior and superior to 20%.

Quality and validity of data - Assumptions and scenarios

➢ Life cycle of cork stoppers

Comment:

It is abusive to consider that the carbon capture of the oak forest could be, even indirectly, attributed to Corticeira Amorim. (Cf section 21)

PwC/Ecobilan's response:

The sensitivity analysis performed considers that the exploitation of the cork oak forest is largely made possible by the activities of Corticeira Amorim, and therefore part of the positive impact on carbon capture of the oak forest could be indirectly attributed to Corticeira Amorim. In the sensitivity analysis it was only attributed to Corticeira Amorim the impact corresponding to the amounts of cork used for cork stoppers, when compared with the total impact in CO_2 retention from the total forest.

Comment:

The consumptions of coagulant and flocculants are considered as insignificant despite the fact that there quantities consumed are higher than for NaOH which is modelled!

Comment:

The origin of H_2O_2 should be known (from Portugal ?)

Comment:

The production of sulfamic acid is not modelled considering that the quantities used are not significant. But these quantities are higher than for Hydrogen Peroxide and Sodium Hydroxide. Here also information should be found from the supplier.

PwC/Ecobilan's response:

LCA model was reviewed in accordance with this recommendation and all the chemical products used in cork stoppers production were included. Data used is presented in Table 4.

Comment:

In some chapters, you should use homogeneous units (kg instead of g)

PwC/Ecobilan's response:

LCA model was reviewed in accordance with this recommendation.

Comment:

Is the distance used for transportation of the treated cork from different plants calculated by taking into account the quantities transported?

PwC/Ecobilan's response:

Yes.

Comment:

There is no information concerning the transport of the finished stoppers. Are they packed before transportation (big bag or board packaging) or are they put unpackaged in a truck ?

PwC/Ecobilan's response:

Stoppers are transported inside big bags placed over wood pallets (whose weight was included in calculations). This information was included on Table 4.

Comment:

For the bottling, the amount of PVC used should be express in g (and not in kg) to facilitate the comparison with the cork stopper weight.

PwC/Ecobilan's response:

LCA model was reviewed in accordance with this recommendation.

- Life cycle of aluminium closure

Comment:

It has been considered that the production of aluminium sheet for closures is made with 35 % of secondary aluminium. This must be check (secondary aluminium is more used in thick product (motors) than in thin products (sheet).

PwC/Ecobilan's response:

We have used data from Association Francaise de l'Aluminium, which refers that 35% of the total aluminium put on the French market comes from recycled aluminium. Once more, worst case scenario for cork stoppers was used (i.e., even if only virgin aluminium is used for the production of aluminium sheet, we are considering the recycled aluminium scenario).

Comment:
Despite the fact that the size of aluminium closures (30x60) is not the same than for cork stoppers (45x24) and for plastic closures (43x22), it was assumed the same number of closures by truck in all the cases. This assumption seems strange and a sensitivity analysis should be done taking into account a difference in apparent density.
PwC/Ecobilan's response:
Considering your recommendation, number of closures by transport was recalculated and the LCA model was uptated. Data considered is presented on Table 4.

- <u>End of life of the closures</u>

Comment:
A big amount of the closures is let on the bottle by the consumer and is recovered threw the collection of glass for recycling. The collection rate should be taken into account, considering that 100% of the aluminium recovered is recycled and that there is no recycling for the cork and plastic.
PwC/Ecobilan's response:
We do not have any information on the collection of used aluminium closures in UK, neither regarding closures that remain on the bottle, neither regarding closures collected with other wastes (plastic and aluminium closures can be collected with other plastic and aluminium wastes). What was done was to use the general collection and recycling rate for plastic and aluminium in UK.

Comment:
Aluminium is also recovered threw the incineration (in the bottom ash) with a yield which can be estimated at 50 %.
PwC/Ecobilan's response:
We have considered UK scenario regarding aluminium recycling (32% recycling, 68% landfill), that does not include incineration.

Comment:
The recycling rate for plastic is unrealistic. It is not necessary to assume that the stopper is made 100 % from PE as a mixture of polyolefin (PE + PP) mixed with PE is easily recyclable.
PwC/Ecobilan's response:
LCA report was reviewed accordance with this recommendation.

Comment:
Precise in the cork degradation the unit of gas emitted (kg of CH_4 per year ?)
PwC/Ecobilan's response:
The available information regarding cork behaviour in landfill is not sufficient; in this survey it was considered that cork's behaviour would be similar to wood in terms of biogas production. The LCA report was completed referring also that cork degradation considered was 0.05 kg landfill gas (50% CH_4 50% CO_2) per kg of cork in the landfill.

<u>Results interpretation and conclusions</u>

The results are clearly presented.

Comment:

The comparison is made between the corks stoppers and the aluminium and plastic closures. The conclusion between the corks stoppers and the 2 other closures don't suffer any doubt. Unfortunately, due to the fact that the production steps of aluminium and plastic closures are not modelled, the conclusions between aluminium closures and plastic closures are not robust.
It would be better to present the result with 2 figures for each impact (cork stopper vs aluminium closure and cork stopper vs plastic closure) not to be able to compare aluminium and plastic.
PwC/Ecobilan's response:
The diferences in the systems studied are specified at the LCA report, in sections 6.1 and 6.2. In addition, we have included on section 20 of the LCA report specific notes on the consideration of existent diferences when comparing performances of the different closures.

Comment:
Recycling of aluminium should appear, but not recycling of plastic (cf comments supra)
PwC/Ecobilan's response:
Answer provided above.

➢ <u>Sensitivity analysis and simulations</u>

Comment:
§ 21.1 The results of the sensitivity analysis concerning the composition of the plastic closure are so similar (the differences are no significant except for Eutrophication) that it is impossible to conclude as you did.
PwC/Ecobilan's response:
We have rephrased the conclusions, referring results are very similar between the 3 scenarios analysed, except for eutrophication.

Comment:
§ 21.2 The hypothesis taken are erroneous. It is not possible to compare the 35 % (secondary aluminium rate in the global French production) and the 32 % (recycling rate of the aluminium stoppers you decide to take).
PwC/Ecobilan's response:
This sensitivity analysis was removed from the LCA report.

Comment:
§ 21.4 Is the forest of cork oaks cultivated or wild? What is the total weight of cork extracted compared to the total weight of wood produced at the end of life of the tree?
PwC/Ecobilan's response:
This information was included in §6.1.1.

Comment:
Is the wood used for other purposes? Except if you decide to allocate by economic value, considering that the residual value of the wood is negligible compare to the value of the cork, you can't allocate 100 % on the cork with a mass allocation.
PwC/Ecobilan's response:
The tree is 100% used for Corticeira Amorim products, the sensitivity analysis only includes the mass of cork used for natural cork stoppers.

Comment:
§ 21.6 The context analysis is erroneous.
PwC/Ecobilan's response:
The objective of this analysis is to evaluate the impact of considering avoided impacts associated to aluminium recycling (as done in the case of plastic closures).

<u>Miscellaneous and editorial remarks</u>

Comment: This study will be used by Corticeira Amorim in its policy and activities carried out all over the world. If Corticeira Amorim use only the conclusions of the study, there is no problem. But If this study is published, the reader will be able to compare also aluminium closures and plastic closures. As the result are not robust, the necessary must be done to avoid this possibility.
PwC/Ecobilan's response:
As referred above and in order to fully clarify this issue to the readers of this report, specific notes on the consideration of existent diferences when comparing performances of the different closures were included on §20.

Comment: The Appendix 1 gives as results for greenhouse effect an impact given undoubtedly by the end of life of cork stopper. It could be interesting to make test to check the biodegradability of cork compare to wood.
PwC/Ecobilan's response:
As referred in §4 of the summary of the survey, additional studies on this issue are being developed by Corticeira Amorim.

Conclusion

- The different chapters seems to answer to the norms 14044:2006;
- The methods used to realize the LCA are coherent with the norm 14044 and satisfying on a scientific point of view;
- The data are appropriate with the objectives of the survey;
- The report is clear and transparent.

The final report published shall be coherent with all the comments made in this critical review

26 Comments made by independent specialist on cork and PwC/Ecobilan's responses

General comments:

The Life cycle analysis report by PricewaterhouseCoopers/Ecobilan on the evaluation of the environmental impacts of cork stoppers as compared to aluminium and plastic closures for wine is well done and clearly shows the advantages / disadvantages of each type of closure. The natural cork stoppers produced by Amorim & Irmãos have clear advantages in terms of carbon dioxide emissions. I shall comment a bit more on this topic regarding the relationship between cork use and carbon sequestration.

The carbon sequestered annually by an ecosystem, i.e. the net ecosystem productivity (**NEP**) is equal to the total photosynthesis or gross primary production (**GPP**) minus total ecosystem respiration (**R**eco). The plant biomass available for human use is the net primary productivity (**NPP**) i.e., the gross photosynthesis minus plant respiration. If the ecosystem is exploited commercially, the part of NPP harvested needs to be included either as a loss (food and fodder) or as carbon storing product (wood or cork). To evaluate the carbon sequestration by cork we need to estimate cork production and storage in cork products – estimate done in the LCA – and carbon sequestered in the ecosystem that is left after cork harvest. Contrary to timber, cork harvested is only a small part of each tree, which go on living after bark stripping.

To evaluate this problem up to the farmer's gate we looked at the average cork production in a typical cork oak "montado" specialized for cork production, in Herdade da Machoqueira do Grou near Coruche (Portugal). It is in the Sorraia Valley, a left bank tributary of the Tejo River, ca. 100 km NE of Lisbon (39°57'N; 8°32'W). The soils are largely sandy and poor in nutrients. The mean average annual rainfall is around 600 mm with a mean annual temperature of 15°C. The cork oak stands (open woodlands) in Machoqueira have average density of 88 trees ha^{-1}, average crown projection area of 2,600 m^2 ha^{-1}, and average tree height of 7.5 m. No fires were reported in the last 100 years. Some tree decline is observed, in Machoqueira[12], however (*ca.* 195 +/- 3.3 trees per hectare according to N. A. Ribeiro, University of Évora, Portugal) [1]. The average cork production in Machoqueira was 86±13 arrobas ha^{-1}, i.e. 1286 ± 199 kg ha^{-1} in dry mass or 643 kg[C] ha^{-1}. The annual increase in wood of the trees on the trunk length allocated to cork stripping (assuming a wood density of $0.86gcm^3$) was 19 kg of carbon per tree. The height of the trunk where cork stripping is allowed is a proportion (2x to 3x) of the tree CAP (circumference at breast height)

Second we assessed the rate of carbon sequestration, NEP, in several ecosystems in central Portugal (Table 1) for 4 years to 1 year. We used the eddy covariance method in three of these CARBOEUROPE sites and the inventory method in the 4th, a pine grove, near Pegões. The latter is a pure pinion pine (*Pinus pinea*) stand aged 40, with 120 trees/ha and dominant height = 16m (Correia, A.P. and Carvalho, P.O., unpublished). The values measured in the "montado", at Mitra (Évora) was 63 $g[C]m^{-2}ano^{-1}$ [2]. As shown in Table 1 this corresponds to 2.3 tons of CO_2 per ha and per year. Although we did not measure carbon sequestration in Machoqueira, considering that it has a greater tree density and better soil fertility than Mitra, we estimated NEP as 100 $g[C]m^{-2}ano^{-1}$, i.e., sequestering annually 3.5 tons of CO_2 per ha. This seems likely because it is between the Mitra (Évora) "montado" and the pine grove at Monte Novo (Table 1).

Table 1. Net ecosystem productivity (NEP) for different ecosystems in Central Portugal.

Forest type, town	**Location, Lat., Long.**	**$t[CO_2]ha^{-1}ano^{-1}$**	**Standard Error**
"Montado", Évora	38º 32'N; 8º 00' W	2,3	1,0
Eucalypt plantation, Pegões	38º 38'N; 8º 36' W	22,8	3,6
Improved pasture, Évora	38º 28'N; 8º 01' W	2,6	(2 years data)
Pinus pinea, Monte Novo	38º 28'N; 8º 38' W	5,5	Inventory method

The plant biomass available for herbivores and human use, i.e., the net primary productivity (NPP) is the gross photosynthesis minus plant respiration. The NPP estimated for the tree component[13] of Machoqueira was near 2.6 t (biomass) $ha^{-1}year^{-1}$ or in carbon ca. 129 $g[C]m^{-2}year^{-1}$. We did not consider tree mortality.

If our numbers are realistic, for NEP and NPP of Machoqueira the cork extracted from the oak trees of the stand is about 6% of the NPP of the trees during the cork production period (9 years). This percentage is well within the error attached to more accurate estimates of NPP and therefore is an almost negligible fraction of tree biomass productivity of a healthy "montado". These are tentative estimates that need to be improved by direct measures. Nevertheless they substantiate the idea that cork harvest although intrinsically dependent upon the existence of the cork-oak "montado" does represent a drain in the ecosystem stock.

[12] Data provided by N. A. Ribeiro, University of Évora, Portugal.
[13] Note: The NPP of irrigated maize in carbon is ca. 21 t (above ground biomass) $ha^{-1}year^{-1}$, i.e. in terms of carbon 9 to 10 t[c] $ha^{-1}year^{-1}$(P.A. Pinto, personal communication). The fact that the cork trees of the "montado" in Machoqueira have NPP of 13% of that of maize seems to be reasonable.

The fact that cork stripping does not kill the trees and that the amount harvested is an almost negligible component of the carbon flux (NEP), i.e. 7%. Therefore considering the ecosystem carbon stock, the turnover time of cork harvest is so high that loses meaning in this context. This leads to the conclusion that cork harvest does not affect ecosystem sequestration. The amount of carbon sequestered by the "montado" should be credited as an asset in cork production. The weight of cork "exported" from the ecosystem as stoppers – calculated in the LCA – should then be credited in addition.

To maintain a high level of carbon stocks in the whole ecosystem however, there is the need of good agronomy practices, namely avoiding forest fires and soil mobilization. In the case of fires, there is a good record: Cork oak stands burnt at least twice less often than the other 2 main forest species in Portugal (eucalypt and maritime pine) in the first five years of 21st century. However, soil harrowing not only reduces the biomass of the grass and shrubs in the following months – thus reducing risk of fire – but leads to a lower NEP than normal due to high soil respiration i. e. enhanced release of CO_2 from the soil. In the same way tree decline may reduce carbon balance and eventually carbon stocks of the "montado".

Specific comments:

1. The sentence, "stripping is carried out manually in spring or summer when the tree is growing strongly and the bark comes away easily from the trunk". Could be better as: stripping is carried out manually in late spring and summer when the cork producing tissue (cork cambium) is active. Then a new bark begins to form behind the newly exposed trunk surface.
PwC/Ecobilan's response:
LCA report was reviewed accordance with this recommendation

2. It was a pity that parts of the he process for the production of aluminium closures were omitted due to lack of data. It is convincing the assertion in the report that had that analysis been done, the relative position of cork stoppers would have been improved.

References

1. Aronson, J., J.S. Pereira, and J.G. Pausas, eds. *Cork Oak Woodlands in Transition: Ecology, Adaptive Management, and Restoration of an Ancient Mediterranean Ecosystem*. Science and Practice of Ecological Restoration. 2008, Island Press: New York.
2. Pereira, J.S., et al., *Net ecosystem carbon exchange in three contrasting Mediterranean ecosystems - the effect of drought.* Biogeosciences, 2007. **4**: p. 791-802.

27 Comments made by Plastic association and PwC/Ecobilan's responses

Comments

- Summary

Comment:
- p.6/111- Critical review panel

The producers of the bottle closures studied have been clearly identified (Amorim, XPTO, XPTO). It would have been fair to include XPTO and XPTO in the panel (EAA can perhaps be considered as representing also XPTO, but this is not the case for APME/PlasticsEurope vis-à-vis XPTO).

PwC/Ecobilan's response:

The plastic and aluminium closures selected represent typical closures (namely regarding size and characteristics) and therefore can be representative of the UK market. The name of the producers will be deleted from the report.

Comment:

- p.7/111 – Comparative environmental appraisal

"The comparison of the environmental impacts of the three types of closures was carried out on the basis of an identical service rendered"

Indeed, to comply with LCA-related ISO standards mentioned on p.6, LCA studies intended for supporting "*environmental claim regarding the superiority or equivalence of one product versus a competing product*", LCA studies have to compare products "*that perform the same function*"

This is however far from being the case with this report!

The expected service is to ensure the proper conservation of the wine content until the bottle is opened by the user. This includes not only the prevention of spilling or evaporation of the wine, but also the guarantee that the quality of the content will not be adversely impacted (oxydation, cork taint...).

The report assumes, without mentioning it, that all three types of closures guarantee the same conservation of the bottles' content (0% loss). It is well known, and easily verifiable by a simple literature search (Internet: 284000 documents corresponding to cork taint), that 5-7% of wine bottles are ruined by cork taint as easily detected by non-experts. The proportion detectable by experts is much higher.

A comparative LCA of wine bottle closures should not only take this efficiency rate into account, but also include in the environmental impacts those associated with the lost wine production.

Otherwise, the comparative LCA report can not be claimed as complying with ISO standards.

PwC/Ecobilan's response:

According to the LCA scope, the functional unit used is "sealing a standard bottle of wine bottled sold on the UK market" and therefore it refers to wine bottles sold in the UK, not consumed.

Failure rates for all types of closures – plastic, cork or aluminium – have never been assessed using strictly scientific methodology. As a result, screwcap-induced reduction, cork-induced TCA or plastic-induced oxidation are often mentioned in international media as commonly occurring faults that can negatively impact wine; but no hard quant data exists that details such failure rate for any of the closures under assessment in this LCA. In the absence of fact-based knowledge, the functional unit selected does not include this information.

Comment:

- p.7/11

"The main results of this comparison are:

-....

-....."

To more completely (and correctly) reflect the results given in table 11 on p.45, and to remain neutral, it would be preferable to replace the two bullets with a table showing the ranking (1-2-3) of the three alternatives for each of the 7 impact categories. This would give a global image of the environmental profile of each closure according to the assumptions of this report. The reader is perfectly able to draw his own conclusion.

PwC/Ecobilan's response:

LCA report was reviewed accordance with this recommendation

- Definition of the field of research

Comment:

- p.12/111 Section 4 Methodology used and Section 5.1 Functional unit

" This report has been prepared in conformance with the methodological stipulations of the following standards: ISO 14040 and ISO 14044."

"*Each one of the different closures considered on this survey is studied for an identical service rendered to customers*".

PwC/Ecobilan's response:

Answer provided above.

Comment:

- p.21/111 Section 6.2.2 List of excluded LC stages - last bullet

- Transport of raw materials for the production of plastic ;

Does this mean that the impacts of transport, included in the LCI of plastics as published by PlasticsEurope, has been deducted from these LCIs? Or simply that the transport from the gate of the raw materials' production plant to the converter's plant was excluded?

PwC/Ecobilan's response:

We referred to the impact associated with the transport of the different types of plastics granules used as raw material from its production site to the stoppers production site was not included. In the sequence of the peer review process, the LCA model was changed, including an estimation of the impact of this transport.

- Calculation of inventory

Comment:

- p.37/111 - 1. Cork stopper in Controlled Landfill

"*Regarding cork behaviour and technologies of landfill disposal, the main assumptions for the cork stopper end of life are:*

• Covered landfill with 50% of landfill collected;

• Presence of a system of treatment of the leachate"

Do these assumptions represent the conditions prevailing in UK (situation of processing household waste, section 3 / p.7)? If not, when is it assumed that such conditions will be fulfilled in UK?

PwC/Ecobilan's response:

50% of landfill gas collection is a minimum for UK landfills. This information was included at the report.

Comment:

- p.38/111 - 18.2 Electricity production models

"*However, particularly for sub-systems relative to the production of plastics used for the production of plastic closures, as the data chosen is representative of the European average, the electricity model corresponds to the mean situation in Europe*"

In PlasticsEurope ecoprofiles for the production of plastics, the electricity production data are data corresponding to the actual production of the plant at the date of collection (on-site, national grid or European average depending on availability and relevance). Does the statement mean that PlasticsEurope LCI data have been modified? Or does it simply mean that plastics raw materials data represent European averages (for the whole LCI, not for electricity) ?

PwC/Ecobilan's response:

The TEAM model is the direct transcription of the PlasticsEurope data. This sentence refers to the granule transformation. The information at the report was changed, in order to clarify this question.

- Results

Comment:

- 19 Limits of the survey - p.40/111

The most severe limitation of the study is the lack of compliance with ISO standards as far as the "identical function" is concerned. Unless the report is modified to ensure this identity of function, this non-compliance aspect should be mentioned.

PwC/Ecobilan's response:

Answer provided above.

Comment:

- 19 Limits of the survey - Uncertainty range of LCA results

Another limitation, as for any LCA study, stems from the uncertainty range of LCA results (effect of data quality, assumptions ....). It should be highlighted that impact differences lower than x% (20? 25?) are not significant in comparative LCA studies. This has to be kept in mind when comparing results.

PwC/Ecobilan's response:

Regarding the interpretation of results and in order to analyse differences in results between stoppers we propose Table 12, with a differential scale as compared to the best stopper. In order to allow a better evaluation of the significance of the differences found the differential scale used was chaged, and not outstands diferences inferior and superior to 20%.

Comment:

- p.52/111

"The comparison of the environmental impacts of the three types of closures was carried out on the basis of an identical service rendered"

Same comment as above on the *"identical function"*

PwC/Ecobilan's response:

Answer provided above.

Comment:

- p.63 /111

For sake of consistency (*Summary 1. Context of the survey*) Ref 16 "*ISO 14041*" should be replaced by ISO 14044

PwC/Ecobilan's response:

LCA report was reviewed accordance with this recommendation

- Miscellaneous

Comment:

Putting in perspective the relative importance of the botttle closure system compared to the LC of wine (including its packaging) would give the reader a correct idea of what the report is talking about, without preventing readers/users to make their own better informed decision.

PwC/Ecobilan's response:

There are no global, encompassing studies using strictly scientific methodology that can give reliable info for wine life cycle. Corticiera Amorim is aware, however, that the wine industry has in progress some important studies on this matter. When this information is available, it wil be possible to complete an LCA analysis of wine closures with this information.

Appendix I – Summary of other environmental surveys on cork stoppers

1 Life Cycle Assessment of a single-piece natural cork stopper for oenological use

- **Description of the survey**
  - Survey carried out by ECOBILANCIO ITALIA;
  - Objective: to list and quantify the environmental impacts related to each phase of production, life and disposal of natural cork stoppers

- **Hypotheses**
  - The study applies to a type of single-piece natural cork stoppers with standard characteristics:

    Specific weight of the cork used - 120 - 220 Kg/m³
    Average moisture of the material – 4%
    Longitudinal dimension – 44 mm
    Diameter – 24 mm
    Nominal weight – 3,4 g

  - Three end of life scenarios were considered: 100% incineration; 100% recycling; 100% landfill disposal;
  - Results are valid for Italy.

- **Indicators studied**
  - Greenhouse effect;
  - Acidification;
  - Heavy metals;
  - Winter smog;
  - Photochemical summer smog;
  - Use of primary energy;
  - Production of solid waste.

- **Results and comments**
  - Greenhouse effect: The phase showing greater impact is undoubtedly the end of life of the stopper. The impacts connected to some phases of 'refining' of the product are also notable;
  - Acidification: The main sources of these pollutants are found in all phases which directly or indirectly require burning, particularly if fossil fuels are used;
  - Heavy metals: Emissions of heavy metals into the environment are connected to the Italian electricity production mix, which is heavily dependent on fossil fuels;
  - Winter smog: The macro-phase mainly involved is the production of stoppers which requires a large amount of electricity and thermal energy;
  - Photochemical summer smog: Regarding stopper production, the responsibility for the impact is to be attributed to the Italian electricity production mix;
  - Use of primary energy: The 'macro-phase' which requires the highest amount of energy is stopper production. The situation in the production phase is similar to that seen for the greenhouse effect - the only substantial difference is the relevance of the contribution of

thermal energy from the burning of dust in the different phases of finishing and in the boiling of planks;

- Production of solid waste: The overwhelming majority of solid waste (more than 99.9%) comes from end of life disposal. In the production phase, all cork shavings are somehow recycled.

Appendix II – General methods for life cycle analysis

The evaluation of industrial systems is not a recent discipline. The first attempts to evaluate the environmental impacts of a product procedure were made in the mid-70s and were centred uniquely on energy aspects[14].

The term “Life Cycle Analysis” or “Life Cycle Assessment” was introduced during workshops organized by the SETAC (Society of Environmental Toxicology and Chemistry). According to standards defined by practitioners, taken up by the SETAC and formalized in national or international standards (AFNOR X 30-300 and ISO 14040 respectively), the environmental assessment of a product is carried out in four phases[15]:

Definition of objectives and field of research, (first definition of the system boundaries, functional unit, data to be collected …),

Analysis of the inventory, phase of the inventory listing the flows of materials and energy (impact factors) for a defined system,

Evaluation of impact, phase interpreting and analyzing the impacts on the environment, carried out on the basis of figures in the inventory and synthetic indicators, carefully chosen and representative of specific impacts,

Interpretation, phase analyzing the procedure, including identification of strengths and weaknesses in the procedure and any analysis of specific scenarios.

2 General methodology for life cycle analyses

The life cycle inventory consists of noting the energy and material flows – or impact factors on the environment – within the boundaries of the system studied. These flows are related to a unit called the functional unit.

The object of these sections is to present the various phases of the inventory, from definition of the functional unit through collection of data on site, via definition of the system and choice of allocation rules and rules for taking into account recycling of products at the end of their life.

2.1 The functional unit

The flows listed in the inventories are not calculated on physical product quantity, but on the basis of an equivalent service rendered.

For example, during evaluation of the respective advantages of different types of packaging, 1 kg of glass would not be compared with 1 kg of plastic material, but a comparison would be made between a litre of liquid packaged in either X g of non returnable glass, Y g of returnable glass (Y being a function of the number of re-uses of the bottles) or Z g of plastic material.

---

14 Handbook of industrial energy analysis. Boustead I. & Hancock G.F. - Ellis Horwood (1979)

15 ISO/14040 . International Standardisation Organisation, (1997), Environmental management – Life cycle analysis – Principles and framework.

Choice of this unit must be conditioned by the fact that aim of a product's inventory is to evaluate the impacts of that product on the environment, **fulfilling a given function.** The functional unit must therefore be a **unit of use** and not simply a unit of manufacture (tonnage or volume for example).

This unit, called the "functional unit" in accordance with European LCA inventory terminology, is the basis for calculating the flows assessed.

2.2 Delimitation of the system

The objective of the LCA inventory is to recognize, understand and interpret all the impacts on the environment of a given system which, according to the problem envisaged, can be:

- All the life cycle stages of a given product;
- The stages of a given process, for a given product;
- A production site for a given product.

The flows listed within the boundaries of the system must be directly interpretable in terms of environmental impact. Thus, consumption of gas oil is not directly interpretable, however this consumption corresponds to a particular quantity of crude oil extracted, transported, refined then burnt, with each of these stages having impacts on the environment.

Interpretable flows are those directly drawn from or discarded into the environment and are called elementary flows. They can be:

- Input into the system: raw materials and certain forms of energy (wind, solar, hydraulic,…);
- Output from the system: liquid or gaseous waste, final solids and certain energy flows (heat, ionizing radiation, …).

These are the opposite of the following non elementary flows:

- Input into the system: extracted materials, intermediate products, steam, electricity, …;
- Output from the system: packaging waste, energy produced, ….

Thus, the system must include the stages enabling these elementary flows to be reached, such as development of intermediate products and the production of consumed energy.

Generally speaking, such a system includes the following stages (as well as transport) that are treated as sub-systems:

- Extraction of raw materials and production of the components parts of the finished product;
- Assembly / formulation of the finished product;
- Distribution;
- Use;
- End of life processing of the product.

More generally, the LCA broadens the system to include the production procedures for each input flow, up to their constituent raw materials.

Output flows from the system must similarly be monitored up to final waste in the natural environment or dumping.

The procedure for broadening the system described above is simple in principle: all the stages enabling ascent to or descent from the elementary flows are taken into account in the system.

However it cannot be conducted exhaustively for the following reason:

> **Inclusion of all the stages contributing to the life cycle of a product entails study of the whole of the industrial world: construction of capital goods (factories, lorries, ships, etc.…), roads and port infrastructures necessary for transport, etc.…**

Thus the procedures included in the system concerning the development of intermediate products consumed and the discarding of output flows up until their transformation into final waste must be clearly stated.

The choice of boundaries for the system studied – by nature conventional and dependent on the objectives of the LCA inventory – must be based on criteria which are:

- Quantitative: for example, percentage of mass or energy content in relation to the mass of the product studied;
- Qualitative: for example, toxicity (inclusion of a procedure said to be polluting even if it makes only a minor contribution to the total product).

Integrated into the elementary flows are:

- Materials with a non-energy use, consumed on site and for which the extraction or production is not taken into account; these are materials used in small quantities;
- Liquid effluent and atmospheric emissions;
- Some solid waste products, in the absence of data concerning their discharge procedures.

Note on capital goods: the following example offers a schematic representation of the (generally negligible) incidence of capital goods on the life cycle of a product (limited to an energy evaluation). The example of steel manufacture has been used to evaluate the cost in energy terms of fabricating a refinery. A refinery processing 6 million tonnes of raw product per annum over 15 years requires around 20 000 tonnes of steel for its construction. The preparation of a tonne of steel requires approximately the energy equivalent of one TOE. The steel working then requires energy of 0.0002 TOE/ tonne of refined oil, or 0.02%, which is negligible compared to the energy consumed in extracting, transporting and refining the oil (around 10% of the energy delivered).

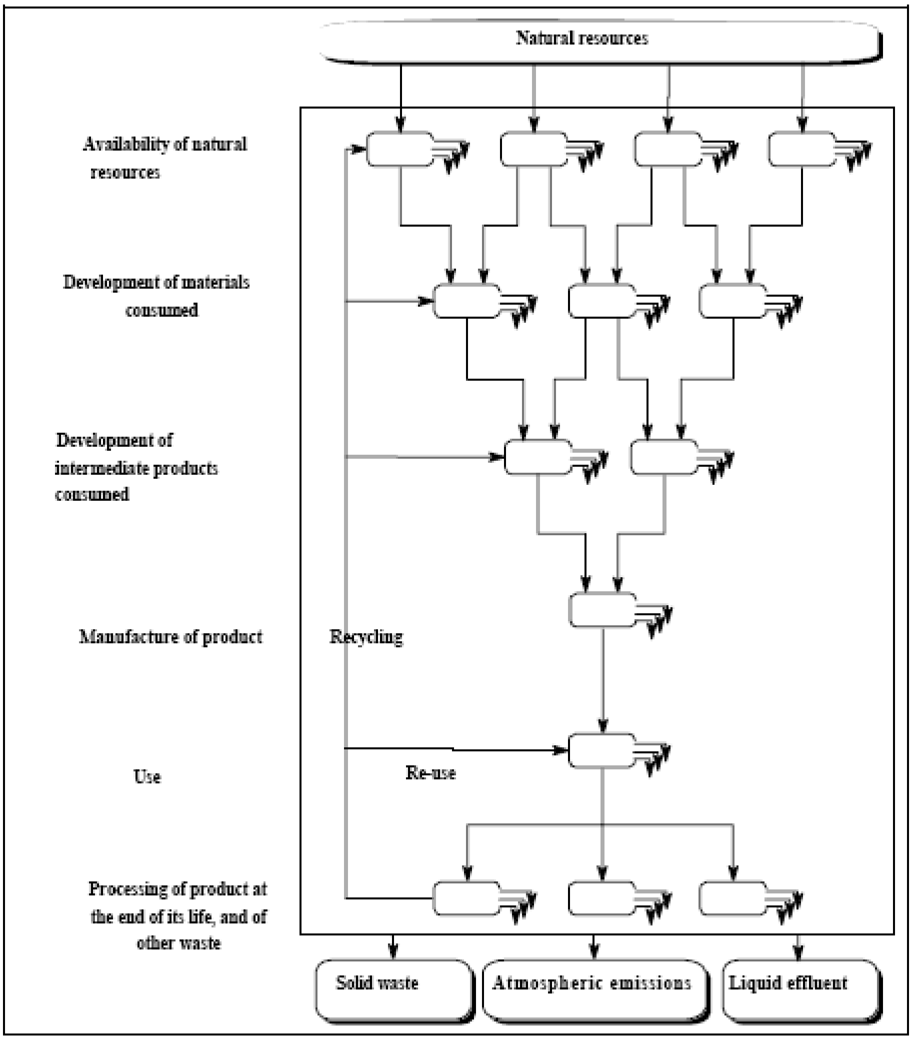

Figure 13: Methodology - Delimitation of the system

2.3 Data collected

For each stage identified within the system, the following flows (known as impact factors as they are a source of environmental impact) should be listed:

- **Energy consumption**, differentiated by origin: electrical energy from the grid, energy from fossil fuels, etc;
- **Consumption of raw materials**, renewable or not (water, ores, etc.);
- **Liquid effluent**: suspended matter, chemical (and biological) demand for oxygen, hydrocarbons, nitrates, sulphates, phenols, etc;
- **Atmospheric emissions**: CO, CO2, NOx, N2O, SOx, CH4, dust, volatile organic compounds, hydrocarbons, metals, etc;
- **Solid waste,** classified by type (paper, plastic, metal, glass, etc.) or destination (dumping, incineration, recycling, energy recovery, etc.).

This collection of data concerns all the industrial stages included in the system as well as the transport stages, availability of energy (electrical and thermal energy) and consumption of packaging and exterior packaging.

Figure 14 shows the data that must be collected at each life cycle stage.

This quantitative data is, first and foremost, that measured by the industrial sites involved in the procedure.

As a last resort, data from other manufacturers producing similar products may be used. This data is then generally of bibliographical origin.

In accordance with the principle of transparency applied to the preparation of LCA inventories, this type of choice is always explained.

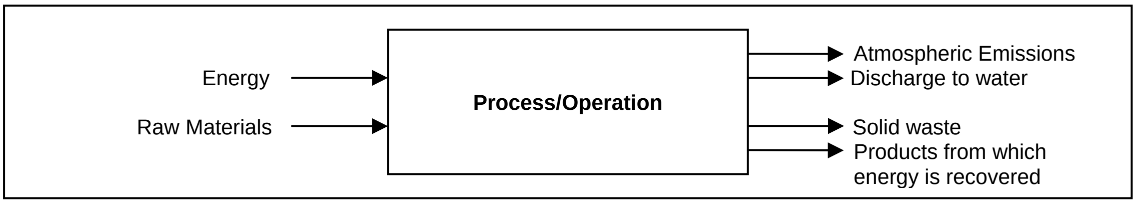

Figure 14: Methodology – Data recorded for each module

Bibliographical data may be presented in three forms:

- **"Raw" LCA inventory:** only the final results of the inventory are accessible;
- **Documented LCA inventory:** all the information sources are referenced and explained;
- **Broken down bibliographical data:** data is distributed between several sources (i.e. each source deals with only one aspect of data). The LCA inventory calculated via this route corresponds definitively to a model which is internal to the company ECOBILAN and which can be refined over time.

Data obtained in the latter two cases can be adapted to the analysis of particular procedures.

However, taking into account the relatively recent character of the notion of environmental assessment, the last case is the most frequent. Furthermore, data available in scientific literature often only allows an inventory of material and energy consumption to be drawn up. The origin and nature of the data must be made clear to enable the LCA inventory to be completed once the data is available or measurements have been taken.

To summarize, bibliographical data makes up for the lack of information collected directly from the industrial sites involved. Its use is compulsory for processes where observation on industrial sites is difficult (extraction of gas, oil, production of electricity for example). It offers a significant time-saving and has the advantage of allowing the system studied to be extended to stages which could not have been included without it. However, it is preferable to substitute this for data measured on the industrial sites applicable to the system, wherever this is possible.

2.4 Choice of allocation rules

The industrial systems studied are often multi-product (or multi-function). It is thus necessary to be able to allocate to each of the co-products, the impacts incumbent on them, with the aid of allocation rules.

For example, an oil refinery is responsible for bitumen, grease, oil, heavy fuels, gas oil, kerosene and light cuts (naphtha and liquefied petroleum gas: particularly propane and butane).

Generally speaking, a number of processes are responsible for generating the co-products of the chemical industry, since it is rare that a chemical reaction gives rise to the synthesis of only one product. Usually two or even three products are obtained, which may be co-products, or by-products from which energy is likely to be recovered, or even waste with no value.

Where there are co-products, or if some of the by-products of the product studied are subject to energy recovery, the impacts on the environment of the process from which they result must be distributed between the various products.

It is essential that allocation rules are determined in the case of procedures with multiple input flows such as incineration.

Various allocation rules can be used which distribute the process impact factors prorate according to the particular case, to:

- The mass of the products (mass allocation);
- The volume of the products (volume allocation);
- The number of moles in the products (molar allocation);
- The low calorific value of the products (energy allocation).

Several rules relating to different impact factors may be used if the physical nature of the phenomena so requires.

Note: the absence of precise data also means that distribution keys must be used without the processes in question generating co-products: this is the case for a factory which manufactures unrelated products in distinct workshops, and which only communicates information relative to the factory as a whole.

2.5 Choice of rules for taking recycling into account

In the life cycle of products within a procedure, numerous recycling loops may exist:

- Recycling of manufacturing rejects and scrap;
- Incorporation of recycled materials into product manufacture;
- Recycling of products at the end of their life, etc.

Cases where a product is recycled within its own life cycle (known as **closed loop** recycling) are directly taken into account in the LCA inventory prepared, via the functional unit.

Thus, a green glass bottle recycled at a rate of 50% post-consumption, will consume an amount of raw materials two times lower than a non-recycled green glass bottle (disregarding the recycling output).

In contrast there is **open loop** recycling – the most frequent – where the initial product is recycled into another procedure, known as a secondary.

In the latter case, different methods exist for allocating the flows associated with the recycling stages and the material savings made between the procedure used for the initial product and that used for the secondary product. Here again there is a choice of rules for allocating and taking into account co-products. Open loop recycling can be considered either as waste processing from the point of view of the initial product, or as a stage in obtaining raw materials from the point of view of the secondary product.

The effects of the recycling operation entail:

- Collection of products for recycling;
- The actual recycling process;
- The savings in raw materials in the secondary product procedure;
- Adaptation of the processes or products to the use of recycled material;
- Waste removal savings in the primary product procedure;
- The differences introduced into the waste removal procedure for the secondary product.

Choices, on which the final results depend, must then be made between:

- Allocation of all the impacts of recycling to the initial product;
- Allocation of all the impacts of recycling to the secondary product;
- Distribution of all or some of the impacts of recycling between the initial and secondary products.

Theoretically, the analysis of multi-function systems should rule out these choices.

These rules for delimiting the boundaries of the system are the subject of a publication, acknowledged by the profession, in the documentation from SETAC's Leyden workshop (December 1991 "System boundaries" workshop, presented by Ecobilan), and are detailed in the international standard ISO 14044[16].

3 Methods for evaluating environmental impacts

3.1 Greenhouse effect

The "greenhouse effect" is the increase in the average temperature of the atmosphere caused by the increase in the average atmospheric concentration of various substances of anthropogenic origin (CO2, methane, CFC...). The unit used to evaluate the potential impact on the greenhouse effect of a substance is the GWP (Global Warming Potential), expressed in mass CO2 equivalent. The GWP of a substance is the potential greenhouse effect of the instantaneous emission of one gram or one kilogram of the substance in relation to CO2 (source IPCC, 1995). CO2 emissions of biological origin ("biomass CO2") are not counted as greenhouse effect gases of anthropogenic origin, in conformance with international agreements fixed by the inter-governmental panel on climate change (IPCC). The coefficients used to calculate this potential impact on the environment are shown below.

IPCC-Greenhouse effect (direct, 100 years)	g CO2 eq.	IPCC
(a) Carbon Dioxide (CO2, fossil)	g	1
(a) Methane (CH4)	g	23
(a) Nitrous Oxide (N2O)	g	296
(a) Carbon Tetrafluoride (CF4)	g	5700
(a) Halon 1301 (CF3Br)	g	6900

Table 17: Greenhouse effect equivalence coefficients (source: IPCC and WMO 1998)

3.2 Atmospheric acidification

This relates to the increase in quantity of acid substances in the low atmosphere, at the cause of "acid rain" and the decline of certain forests. The unit used to evaluate the contribution of a substance to acidification is the potential to liberate H+ protons (source CML, 1992). As this impact is a phenomenon with regional scope, the result of the global calculation of the impact of a product in terms of acidification must be qualified by the spatial distribution of gas emissions contributing to this effect.

CML-Air Acidification	g eq. H+	CML
(a) Nitrogen Oxides (NOx as NO2)	g	0,022
(a) Sulphur Oxides (SOx as SO2)	g	0,031

16 ISO 14044: Environmental management – Life cycle analysis - Requirements and guidelines

(a) Ammonia (NH3	g	0,059
(a) Hydrogen Chloride (HCl)	g	0,027
(a) Hydrogen Cyanide (HCN)	g	0,037
(a) Hydrogen Fluoride (HF)	g	0,050
(a) Hydrogen Sulphide (H2S)	g	0,059
(a) Sulphuric Acid (H2SO4)	g	0,020

Table 18: Air acidification equivalence coefficients(source: Leiden University. Netherlands)

3.3 Formation of photochemical oxidants

Under certain climatic conditions, the atmospheric emissions of industry and transport can react with the solar photons and produce a photochemical smog. A succession of reactions involving volatile organic compounds and NOx leads to the formation of ozone, a super oxidizing compound. The potential to form photochemical oxidants is expressed in g. ethylene eq. The coefficients used to calculate this potential impact on the environment are shown opposite.

WMO-Photochemical oxidant formation	g ethylene eq.	UN
(a) Hydrocarbons (unspecified)	g	0,377
(a) VOC (Volatile Organic Compounds	g	0,377
(a) Acetaldehyde (CH3CHO)	g	0,527
(a) Acetone (CH3COCH3)	g	0,178
(a) Acetylene (C2H2)	g	0,168
(a) Alcohol (unspecified)	g	0,196
(a) Aldehyde (unspecified)	g	0,443
(a) Alkane (unspecified)	g	0,398
(a) Aromatic Hydrocarbons (unspecified)	g	0,761
(a) Benzaldehyde (C6H5CHO)	g	-0,334
(a) Benzene (C6H6)	g	0,189
(a) Butane (n-C4H10)	g	0,410
(a) Butene (1-CH3CH2CHCH2)	g	0,959
(a) Ethane (C2H6)	g	0,082
(a) Ethanol (C2H5OH)	g	0,268
(a) Ethyl Benzene (C6H5C2H5)	g	0,593
(a) Ethylene (C2H4)	g	1
(a) Formaldehyde (CH2O)	g	0,421
(a) Heptane (C7H16)	g	0,529
(a) Hexane (C6H14)	g	0,421
(a) Hydrocarbons (except methane)	g	0,416
(a) Methane (CH4)	g	0,007
(a) Methanol (CH3OH)	g	0,123
(a) Propane (C3H8)	g	0,420
a) Propionaldehyde (CH3CH2CHO)	g	0,603
(a) Propylene (CH2CHCH3)	g	1,03
(a) Tetrachloroethylene (C2Cl4)	g	0,005
(a) Toluene (C6H5CH3)	g	0,563

Table 19: Acidification equivalence coefficients (source: World Meteorological Organization)

3.4 Eutrophication of water

Eutrophication of an aqueous milieu is characterized by the introduction of nutrients in the form of phosphatised and nitrogenous compounds for example, which leads to the proliferation of algae. In the first instance, this leads to a high consumption of dissolved CO_2 in the presence of light (by photosynthesis) and therefore to alkalizing of the water; and secondly, to bacterial decomposition which leads to a reduction in the content of dissolved oxygen in the water. This phenomenon can lead to the death of flora and fauna in the aquatic milieu in question.

The coefficients used to calculate this potential impact on the environment are shown below.

CML-Eutrophication (water)	g eq. PO4	CML
(w) Ammonia (NH4+, NH3, as N)	g	0,420
(w) COD (Chemical Oxygen Demand)	g	0,022
(w) Nitrate (NO3-)	g	0,095
(w) Nitrite (NO2-)	g	0,130
(w) Nitrogenous Matter (Kjeldahl, as N)	g	0,420
(w) Nitrogenous Matter (unspecified, as N	g	0,420
(w) Phosphates (PO4 3-, HPO4--, H2PO4-, H3PO4, as P)	g	3,060
(w) Phosphorous Matter (unspecified, as P)	g	3,060
(w) Phosphorus (P)	g	3,060
(w) Phosphorus Pentoxide (P2O5)	g	1,336

Table 20: Eutrophication equivalence coefficients (source: Leiden University, Netherlands)

This method only considers eutrophication due to direct water releases. The nitrogen oxides emissions have an indirect impact on water eutrophication although only part of these air emissions finally end up in water.

Appendix III – Secondary data used

4 Bibliographical sources of secondary data

Industrial Processes	Closure concerned	Data sources
Propane production	Cork	ETH, Laboratorium fur Energiesysteme, Zurich, 1996, Teil 1
Propane combustion (modified for Corticeira Amorim)	Cork	EPA (Environmental Protection Agency), AP-42, Vol. I, CH1.5: Liquefied Petroleum Gas Combustion
Diesel oil production	Cork, Aluminium, Plastic	ETH, Laboratorium fur Energiesysteme, Zurich, 1996, Teil 1, Erdol
Diesel oil: Engine Combustion	Cork	ETH, Laboratorium fur Energiesysteme, Zurich, 1996, Teil 3, Anhang B: Transport und Bauprozesse
Natural Gas: Production (APME)	Cork	Ecoprofiles of the European plastics industry, Hydrocarbons raw materials, Ian Boustead, Report for Brussels, July 2003
Natural gas (Low NOx) combustion	Cork	ETH, Laboratorium fur Energiesysteme, Zurich, 1996, Teil 1
Natural gas leakage	Cork	Average composition of natural gas in Europe

Table 21: Bibliographical sources of secondary data

Appendix IV - Life cycle analysis inventories

Each line in the following tables correspond to an environmental flow (sections headed “inputs” and “outputs”) or to a potential impact on the environment (section headed “Methods for evaluating environmental impacts”). In this methods section, the first line which indicates the name of the impact gives the total and the following lines show the contribution of each flow participating to this impact.

By agreement, certain categories of flow (elementary flows inputting or outputting the systems studied) have a particular notation in their title:

- (r) corresponds to consumption of a natural resource drawn directly from the environment. For example, “(r) Oil (in ground)” equates to the consumption of crude oil, whereas “(r) Iron (Fe, ore)” equates to the consumption of iron ore.

- corresponds to an emission to air. For example, “(a) Carbon Monoxide (CO)” equates to atmospheric emissions of carbon monoxide.

- (w) corresponds to an emission to water. For example, “(w) BOD5 (Biochemical Oxygen Demand)” represents emissions in the water of DBO5 (biochemical oxygen demand over 5 days).

Regarding the columns, the table shows, for each type of closure studied, the total associated with each life cycle and its breakdown according to the principal sub stages of this life cycle: production, transport, bottling and end of life. The right hand columns indicate variations in the end of life stage.

NOTE: The tables below are not updated

	Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
Inputs:	(r) Barium Sulphate (BaSO4, in ground)	kg	0,000423192	0,000192603	8,9428E-06	0,0002191	2,54589E-06
	(r) Bauxite (Al2O3, ore)	kg	2,38E-02	2,38E-02	7,69E-06	7,19E-06	4,52E-07
	(r) Bentonite (Al2O3.4SiO2.H2O, in ground)	kg	1,61E-04	1,77496E-05	8,45E-07	2,72E-05	1,16E-04
	(r) Calcium Sulphate (CaSO4, ore)	kg	2,73E-05	9,12E-06	1,44E-06	2,72E-06	1,40E-05
	(r) Carbon Dioxide (CO2, in ground)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	(r) Chromium (Cr, ore)	kg	1,19E-06	6,04E-08	1,72E-09	1,12E-06	9,27E-11
	(r) Clay (in ground)	kg	2,06E+00	8,60E-05	9,75E-06	9,64E-06	2,06E+00
	(r) Coal (in ground)	kg	0,667406	0,310123	0,00171201	0,354519	0,0010519
	(r) Copper (Cu, ore)	kg	1,03E-04	1,84E-07	8,75E-09	1,03E-04	4,72E-10
	(r) Dolomite (CaCO3.MgCO3, in ground)	kg	1,16E-05	3,28E-08	1,79E-12	1,16E-05	0,00E+00
	(r) Feldspar (ore)	kg	2,43E-08	2,43E-08	0,00E+00	5,24E-17	0,00E+00
	(r) Ferromanganese (Fe, Mn, C; Ore)	kg	8,79E-07	1,90E-08	2,45E-15	8,60E-07	0,00E+00
	(r) Fluorspar (CaF2, ore)	kg	8,35E-06	6,12E-06	0,00E+00	2,23E-06	0,00E+00
	(r) Granite (in ground)	kg	2,43E-08	2,43E-08	0,00E+00	2,21E-13	0,00E+00
	(r) Gravel (unspecified)	kg	1,45E-03	1,24E-03	1,97E-04	3,49E-06	5,78E-06
	(r) Iron (Fe, ore)	kg	1,73E-03	5,64E-04	2,63E-05	9,47E-04	1,88E-04
	(r) Iron Sulphate (FeSO4, ore)	kg	9,57E-06	9,49E-06	5,46E-08	0,00E+00	2,38E-08
	(r) Lead (Pb, ore)	kg	3,22E-06	8,84E-08	2,73E-09	3,13E-06	1,47E-10
	(r) Lignite (in ground)	kg	5,81E-03	5,14E-03	1,43E-05	6,26E-04	2,74E-05
	(r) Limestone (CaCO3, in ground)	kg	0,0292651	0,00169118	6,11366E-05	0,027075	0,000437759
	(r) Magnesium (Mg, ore)	kg	1,52E-22	0,00E+00	0,00E+00	1,52E-22	0,00E+00
	(r) Manganese (Mn, ore)	kg	2,21E-08	2,10E-08	1,00E-09	0,00E+00	5,40E-11
	(r) Mercury (Hg, ore)	kg	2,93E-06	0,00E+00	0,00E+00	2,93E-06	0,00E+00
	(r) Natural Gas (in ground)	kg	0,774168	2,22E-01	6,68E-03	5,44E-01	7,08E-04
	(r) Nickel (Ni, ore)	kg	8,19E-08	3,65E-08	5,82E-10	4,47E-08	3,14E-11
	(r) Oil (in ground)	kg	9,65E-01	1,62E-01	2,63E-01	5,34E-01	5,49E-03
	(r) Olivine ((Mg,Fe)2SiO4, ore)	kg	8,91E-06	3,11E-08	2,02677E-13	8,87992E-06	0
	(r) Peat (in ground)	kg	2,96E-04	1,90E-08	0,00E+00	2,96E-04	0,00E+00
	(r) Perlite (SiO2, ore)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	(r) Phosphate Rock (in ground)	kg	0,00196203	1,36E-08	0	1,0314E-06	0,00196098
	(r) Potassium Chloride (KCl, as K2O, in ground)	kg	9,78E-04	2,79E-04	4,37E-08	6,99E-04	0,00E+00
	(r) Pyrite (FeS2, ore)	kg	3,16E-04	3,01E-04	1,43E-05	0,00E+00	7,73E-07
	(r) Quartzite (SiO2, in ground)	kg	1,05E-21	0,00E+00	0,00E+00	1,05E-21	0,00E+00
	(r) Rutile (TiO2, ore)	kg	2,09037E-11	0,00E+00	0,00E+00	2,09E-11	0,00E+00

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(r) Sand (in ground)	kg	0,30696	1,47E-04	3,53E-06	5,91E-04	3,06E-01
(r) Silver (Ag, ore)	kg	9,56E-10	9,10E-10	4,34E-11	0,00E+00	2,34E-12
(r) Sodium Chloride (NaCl, in ground or in sea)	kg	1,09E+00	1,09E-02	3,62E-05	1,08E+00	1,52E-05
(r) Sodium Nitrate (NaNO3)	kg	4,55527E-22	0,00E+00	0,00E+00	4,56E-22	0,00E+00
(r) Sulphur (in natural gas)	kg	0,000194977	0,00E+00	0,00E+00	0,00E+00	1,95E-04
(r) Sulphur (S, in ground)	kg	1,52E-03	1,96E-03	3,06E-09	-4,41E-04	2,56E-10
(r) Talcum (4SiO2.3MgO.H2O, ore)	kg	1,90E-08	1,90E-08	0,00E+00	2,57E-26	0,00E+00
(r) Tin (Sn, ore)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(r) Titanium (Ti, ore)	kg	1,67E-08	1,67E-08	0,00E+00	0,00E+00	0,00E+00
(r) Uranium (U, ore)	kg	6,86E-05	4,04E-06	5,76E-10	6,45E-05	1,24E-07
(r) Wood (standing)	kg	1,55E-03	1,54E-03	8,87E-06	0,00E+00	0,00E+00
(r) Wood (standing, in kg)	kg	6,80E-02	1,30E-02	0,00E+00	5,50E-02	0,00E+00
(r) Wood (standing, kg)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(r) Zinc (Zn, ore)	kg	7,96E-07	2,57E-08	6,36E-11	7,71E-07	3,43E-12
(w) Phosphorous Matter (unspecified, as P)	g	6,81E-10	6,81E-10	0,00E+00	0,00E+00	0,00E+00
_(a) Carbon dioxyde (from air, sink effect)	g	5,87E+03	5874,95	0	0	0
_(r) Cork Standing	kg	3,20452	3,20452	0	0	0
_Biofuel	MJ	0	0,00E+00	0	0	0
Adjuvant (unspecified)	kg	1,58E-13	1,58E-13	0	0	0
Alloy (unspecified)	kg	0	0	0	0	0
Amine (unspecified)	kg	2,75201E-14	2,75201E-14	0	0	0
Antifoaming Agent (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
Biocide (unspecified)	kg	0	0,00E+00	0	0	0
Biomass (unspecified)	kg	0,0174833	1,07E-04	0	0,0173763	0
Catalyst (unspecified)	kg	1,79E-14	1,79E-14	0	0	0
Detergent Agent (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
Dewaxing Agent (unspecified)	kg	8,76568E-13	8,77E-13	0	0	0
Explosive (unspecified)	kg	1,10E-04	1,09E-04	6,28496E-07	0	3,07776E-07
Ferromanganese (Fe, Mn, C)	kg	5,35E-09	5,35E-09	0,00E+00	0,00E+00	0,00E+00
Furfural (C5H4O2)	kg	2,05E-12	2,05E-12	0,00E+00	0,00E+00	0,00E+00
Iron Scrap	kg	3,16E-04	7,17E-05	0,000217349	0	2,70579E-05
Land Use (II -> III)	m2a	1,26E-03	0,00125084	7,57E-06	0,00E+00	0,00E+00
Land Use (II -> IV)	m2a	1,69E-04	1,68E-04	1,44E-06	0,00E+00	0,00E+00
Land Use (III -> IV)	m2a	5,97E-05	5,94E-05	3,41E-07	0,00E+00	0,00E+00
Maize	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Peat	kg	9,20057E-06	9,20E-06	0	0	0

	Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
	Potatoes	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Raw Materials (unspecified)	kg	0,000933398	7,07E-04	0,000198683	1,77009E-09	2,73883E-05
	Recovered Matter (total)	kg	6,05E-01	6,05E-01	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Aluminium Scrap	kg	0	0,00E+00	0	0	0
	Recovered Matter: Iron Scrap	kg	0	0	0	0	0
	Recovered Matter: Others for Energy	kg	0,604678	6,05E-01	0	0	0
	Recovered Matter: Paper, Cardboard	kg	0	0,00E+00	0	0	0
	Sodium Hydrocarbonate (NaHCO3)	kg	0	0,00E+00	0	0	0
	Solvent (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
	Steel	kg	9,42681E-12	9,43E-12	0	0	0
	Trinitrotoluene (C6H2CH3(NO2)3)	kg	0	0,00E+00	0	0	0
	Urea (H2NCONH2)	kg	0	0	0	0	0
	Water Used (total)	litre	25,6431	1,35E+01	1,08161	10,9261	0,138703
	Water: Ground	litre	0	0	0	0	0
	Water: Public Network	litre	3,476	0,0306963	4,09552E-06	3,44529	6,79367E-06
	Water: River	litre	0,889027	1,34682E-07	1,76625E-10	0,889026	0
	Water: Sea	litre	0,202874	5,66135E-05	1,89713E-08	0,202818	0
	Water: Unspecified Origin	litre	20,4092	1,35E+01	1,08161	5,72306	0,138694
	Water: Well	litre	6,66E-01	6,97E-07	9,37E-11	6,66E-01	0,00E+00
	Wood	kg	0,00251865	2,51E-03	2,90974E-07	0	6,58259E-06
	Wood (standing, maritime pine)	m3	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Outputs:	(a) Acetaldehyde (CH3CHO)	g	1,70E-02	2,91E-04	1,85E-06	0,00E+00	1,67E-02
	(a) Acetic Acid (CH3COOH)	g	2,13E-03	2,09E-03	3,96E-05	0,00E+00	2,47E-06
	(a) Acetone (CH3COCH3)	g	2,87E-04	2,86E-04	1,65E-06	0,00E+00	2,11E-07
	(a) Acetylene (C2H2)	g	2,66E-03	2,64E-03	1,52E-05	0,00E+00	6,90E-06
	(a) Aldehyde (unspecified)	g	5,78E-05	5,63E-05	2,56E-07	4,47E-07	8,22E-07
	(a) Alkane (unspecified)	g	4,04E-02	2,41E-02	5,39E-03	0,00E+00	1,10E-02
	(a) Alkene (unspecified)	g	2,89E-03	2,87E-03	1,69E-05	0,00E+00	7,02E-06
	(a) Alkyne (unspecified)	g	3,22E-07	3,06E-07	1,46E-08	0,00E+00	7,87E-10
	(a) Aluminium (Al)	g	5,11E-02	5,07E-02	2,92E-04	0,00E+00	1,28E-04
	(a) Ammonia (NH3)	g	1,41E-02	1,18E-03	9,81E-06	1,28E-02	3,90E-05
	(a) Antimony (Sb)	g	1,52E-05	1,51E-05	5,62E-08	2,42E-09	2,86E-08
	(a) AOX (Adsorbable Organic Halogens)	g	4,26E-14	4,23E-14	2,42833E-16	0	1,05797E-16
	(a) Aromatic Hydrocarbons (unspecified)	g	5,58E-02	1,73E-02	1,62E-06	2,12E-02	1,74E-02
	(a) Arsenic (As)	g	0,000134299	1,25E-04	4,59E-06	4,26E-06	3,29E-07
	(a) Asbestos	g	5,08E-08	0,00E+00	0,00E+00	5,08E-08	0,00E+00

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(a) Barium (Ba)	g	6,13E-04	6,08E-04	3,50E-06	0,00E+00	1,54E-06
(a) Benzaldehyde (C6H5CHO)	g	5,80E-11	5,53E-11	2,63E-12	0,00E+00	1,42E-13
(a) Benzene (C6H6)	g	9,92E-03	7,18E-03	2,25E-03	2,32E-09	4,88E-04
(a) Benzo(a)pyrene (C20H12)	g	9,90E-06	8,57E-06	1,31E-06	0,00E+00	2,61E-08
(a) Beryllium (Be)	g	1,00E-05	9,95E-06	5,72E-08	0,00E+00	2,54E-08
(a) Boron (B)	g	4,86E-03	4,82E-03	2,79E-05	0,00E+00	1,25E-05
(a) Bromium (Br)	g	9,70E-04	9,62E-04	5,56E-06	0,00E+00	2,42E-06
(a) Butane (n-C4H10)	g	4,66E-02	1,38E-02	1,91E-02	0,00E+00	1,37E-02
(a) Butene (1-CH3CH2CHCH2)	g	6,99E-04	2,20E-04	4,72E-04	0,00E+00	7,24E-06
(a) Cadmium (Cd)	g	1,25E-04	1,01E-04	2,23E-05	1,31E-06	2,34E-07
(a) Calcium (Ca)	g	0,00636767	0,00627824	7,11446E-05	0	1,82817E-05
(a) Carbon Dioxide (CO2, biomass)	g	230,946	-0,128371	0	50,4047	180,669
(a) Carbon Dioxide (CO2, fossil)	g	2,59E+02	-3,28E+03	8,61E+02	2,66E+03	1,83E+01
(a) Carbon Disulphide (CS2)	g	2,77991E-05	2,51841E-05	8,36505E-10	2,61424E-06	0
(a) Carbon Monoxide (CO)	g	1,35E+01	7,77151	2,22E+00	3,41E+00	1,19E-01
(a) Carbon Tetrafluoride (CF4)	g	4,66E-08	4,44E-08	2,12E-09	0,00E+00	1,14E-10
(a) Chlorides (Cl-)	g	3,66E-10	0	0,00E+00	0,00E+00	3,66E-10
(a) Chlorinated Matter (unspecified, as Cl)	g	1,10E-02	2,53E-05	1,74E-09	1,09E-02	3,09E-10
(a) Chlorine (Cl2)	g	1,32E-01	3,10E-05	9,67E-10	1,32E-01	3,42E-10
(a) Chromium (Cr III, Cr VI)	g	3,01E-04	1,52E-04	5,74E-06	1,42E-04	4,53E-07
(a) Cobalt (Co)	g	9,42E-05	8,38E-05	1,01E-05	0,00E+00	2,37E-07
(a) Copper (Cu)	g	2,50E-04	2,02E-04	1,55E-05	3,27E-05	5,33E-07
(a) Cyanide (CN-)	g	1,36E-05	1,34E-05	8,33579E-08	0	3,36545E-08
(a) Dichloroethane (1,1-CH2ClCH2Cl)	g	1,89746E-05	1,90E-05	0,00E+00	0,00E+00	0,00E+00
(a) Dichloroethane (1,1-CHCl2CH3)	g	0,0512527	0,00E+00	0	0,0512527	0
(a) Dichloroethane (1,2-CH2ClCH2Cl)	g	5,35E-06	5,35E-06	0,00E+00	0,00E+00	0,00E+00
(a) Dioxins (unspecified)	g	3,106E-07	9,90E-11	6,60E-13	3,10E-07	1,02E-12
(a) Ethane (C2H6)	g	1,33E-01	5,51E-02	6,11E-02	0,00E+00	1,67E-02
(a) Ethanol (C2H5OH)	g	5,74E-04	5,70E-04	3,25E-06	0,00E+00	4,19E-07
(a) Ethyl Benzene (C6H5C2H5)	g	0,00219262	0,000248284	4,72E-04	2,54E-10	1,47E-03
(a) Ethylene (C2H4)	g	0,135916	7,84E-02	0,00375227	0,0153726	0,0383418
(a) Ethylene Oxide (C2H4O)	g	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
(a) Fluorides (F-)	g	6,45E-06	5,92E-06	5,37E-08	0,00E+00	4,77E-07
(a) Fluorine (F2)	g	2,96E-05	2,52E-05	8,37E-10	4,37E-06	1,78E-09
(a) Formaldehyde (CH2O)	g	1,91E-03	1,88E-03	2,92E-05	0,00E+00	2,70E-06
(a) Halogenated Hydrocarbons (unspecified)	g	6,03E-03	1,90E-05	1,46E-11	0,00E+00	6,01E-03

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(a) Halogenated Matter (unspecified)	g	1,57E-02	6,28E-06	1,22E-09	1,57E-02	1,66E-10
(a) Halon 1301 (CF3Br)	g	8,26E-05	2,81E-05	5,36E-05	0,00E+00	8,25E-07
(a) Heptane (C7H16)	g	6,99E-03	2,19E-03	4,72E-03	0,00E+00	7,23E-05
(a) Hexane (C6H14)	g	0,0139721	0,00438265	0,00944482	0	0,000144673
(a) Hydrocarbons (except methane)	g	4,49865	1,60489	2,83068	0	0,0630826
(a) Hydrocarbons (unspecified)	g	2,39298	0,186337	0,000163975	2,19666	0,00982212
(a) Hydrogen (H2)	g	4,70041	0,0522823	1,19217E-06	4,6405	0,00762541
(a) Hydrogen Chloride (HCl)	g	4,99E-01	2,61E-01	1,84E-03	2,30E-01	6,58E-03
(a) Hydrogen Cyanide (HCN)	g	2,52E-05	2,51841E-05	8,37E-10	4,17E-16	0,00E+00
(a) Hydrogen Fluoride (HF)	g	1,71E-02	9,43E-03	9,56E-05	6,34E-03	1,23E-03
(a) Hydrogen Sulphide (H2S)	g	9,52E-03	8,45E-03	1,23E-04	8,77E-04	7,31E-05
(a) Iodine (I)	g	2,43E-04	2,41E-04	1,40E-06	0,00E+00	6,06E-07
(a) Iron (Fe)	g	2,09E-02	2,07E-02	0,00016897	0	5,25133E-05
(a) Ketone (unspecified)	g	2,00E-03	3,55E-09	0,00E+00	0,00E+00	2,00E-03
(a) Lanthanum (La)	g	1,61E-05	1,60E-05	9,18E-08	0,00E+00	4,04E-08
(a) Lead (Pb)	g	7,61E-04	5,57E-04	7,42E-05	1,27E-04	2,37E-06
(a) Magnesium (Mg)	g	1,79E-02	1,78E-02	1,02E-04	0,00E+00	4,48E-05
(a) Manganese (Mn)	g	1,35E-04	1,33E-04	1,84E-06	0,00E+00	6,66E-07
(a) Mercaptans	g	8,95E-03	2,52E-05	8,37E-10	2,50E-04	8,68E-03
(a) Mercury (Hg)	g	3,84E-04	4,69178E-05	5,81E-07	3,37E-04	5,84E-08
(a) Metals (unspecified)	g	0,00463034	0,00154527	3,65255E-08	0,00307619	8,84429E-06
(a) Methane (CH4)	g	5,35E+01	3,91E+00	1,18E+00	2,64E+01	2,19E+01
(a) Methanol (CH3OH)	g	0,000974801	9,69E-04	5,52E-06	0,00E+00	7,11E-07
(a) Methylene Chloride (CH2Cl2, HC-130)	g	3,31E-04	0,00E+00	0,00E+00	3,31E-04	0,00E+00
(a) Molybdenum (Mo)	g	5,82E-05	5,30E-05	5,13E-06	0,00E+00	1,48E-07
(a) Nickel (Ni)	g	0,00185572	0,00145459	0,000201655	0,000194955	4,52035E-06
(a) Nitrogen (N2)	g	0	0	0	0	0
(a) Nitrogen Oxides (NOx as NO2)	g	34,8647	1,79E+01	1,02E+01	6,62E+00	2,11E-01
(a) Nitrous Oxide (N2O)	g	0,152405	0,0380331	0,110258	5,00626E-09	0,00411365
(a) NMVOC (Non Methanic Volatile Organic Compounds)	g	0,0422091	0	0	0,0422091	0
(a) Organic Matter (unspecified)	g	0,11904	0,0463798	2,13387E-07	0,0726586	1,81163E-06
(a) Particulates (PM 10)	g	1,57453	0	0	1,57453	0
(a) Particulates (unspecified)	g	7,18E+00	6,56E+00	5,88E-01	0,00E+00	3,57E-02
(a) Pentane (C5H12)	g	4,28E-02	1,86E-02	2,39E-02	0,00E+00	3,75E-04
(a) Phenol (C6H5OH)	g	4,59E-08	1,64E-08	2,02E-11	0,00E+00	2,95E-08

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(a) Phosphorus (P)	g	4,52E-04	4,48E-04	2,58E-06	0,00E+00	1,13E-06
(a) Phosphorus Pentoxide (P2O5)	g	3,06338E-07	3,04E-07	1,7459E-09	0	7,60651E-10
(a) Platinum (Pt)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(a) Polycyclic Aromatic Hydrocarbons (PAH, unspecified)	g	9,22E-05	8,99E-05	2,22E-06	3,96E-09	1,16E-07
(a) Potassium (K)	g	6,23E-03	6,17E-03	3,95E-05	0,00E+00	1,55E-05
(a) Propane (C3H8)	g	4,66E-02	1,94E-02	1,92E-02	0,00E+00	7,97E-03
(a) Propionaldehyde (CH3CH2CHO)	g	1,60E-10	1,52E-10	7,25E-12	0,00E+00	3,91E-13
(a) Propionic Acid (CH3CH2COOH)	g	2,45E-07	2,35E-07	9,56E-09	0,00E+00	4,96E-10
(a) Propylene (CH2CHCH3)	g	5,15E-03	3,31E-03	9,61E-04	8,52E-04	2,20E-05
(a) Scandium (Sc)	g	5,46E-06	5,42E-06	3,11E-08	0,00E+00	1,36E-08
(a) Selenium (Se)	g	1,28E-04	1,23E-04	4,64E-06	1,17E-08	3,23E-07
(a) Silicon (Si)	g	0,0765789	7,59E-02	4,38E-04	0,00E+00	1,96E-04
(a) Silver (Ag+)	g	5,61E-07	0,00E+00	0,00E+00	5,61E-07	0,00E+00
(a) Sodium (Na)	g	4,86E-03	4,60E-03	2,49E-04	0,00E+00	1,22E-05
(a) Strontium (Sr)	g	0,000999771	9,92E-04	5,70E-06	0,00E+00	2,50E-06
(a) Styrene (C6H5CHCH2)	g	1,31939E-11	0	0	1,31939E-11	0
(a) Sulphur Oxides (SOx as SO2)	g	1,84E+01	8,41E+00	3,97E-01	9,55E+00	6,13E-02
(a) Sulphuric Acid (H2SO4)	g	2,52E-05	2,52E-05	8,37E-10	3,76E-11	0,00E+00
(a) Tars (unspecified)	g	4,88E-07	3,33E-07	1,53E-07	0,00E+00	2,72E-09
(a) Thallium (Tl)	g	5,01E-06	4,96E-06	2,85E-08	0,00E+00	2,00E-08
(a) Thorium (Th)	g	1,03E-05	1,02E-05	5,87E-08	0,00E+00	2,58E-08
(a) Tin (Sn)	g	3,22E-06	3,19E-06	1,84E-08	0,00E+00	8,17E-09
(a) Titanium (Ti)	g	1,79E-03	1,78E-03	1,02E-05	0,00E+00	4,46E-06
(a) Toluene (C6H5CH3)	g	1,74E-02	3,56E-03	2,93E-03	4,54E-10	1,09E-02
(a) Uranium (U)	g	1,00E-05	9,92E-06	5,70E-08	0,00E+00	2,50E-08
(a) Vanadium (V)	g	0,00642597	5,61E-03	0,000804766	0	1,60737E-05
(a) Vinyl Chloride (CH2CHCl)	g	8,37E-02	2,43E-05	2,19E-11	8,36E-02	0,00E+00
(a) VOC (Volatile Organic Compounds)	g	5,54E-02	5,13E-02	0,00E+00	0,00E+00	4,13E-03
(a) Xylene (C6H4(CH3)2)	g	7,24E-03	1,47E-03	1,89E-03	2,17E-10	3,88E-03
(a) Zinc (Zn)	g	4,13E-02	8,22E-03	3,30E-02	1,32E-05	1,66E-06
(a) Zirconium (Zr)	g	7,66E-06	7,60E-06	4,36E-08	0,00E+00	1,90E-08
(ar) Aerosols and Halogenes (unspecified)	kBq	9,51041E-10	9,51E-10	0	0	0
(ar) Americium (Am241)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Carbon (C14)	kBq	3,16005E-07	3,16E-07	0	0	0
(ar) Cerium (Ce144)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(ar) Cesium (Cs134)	kBq	1,21E-11	1,21E-11	0,00E+00	0,00E+00	0,00E+00
(ar) Cesium (Cs137)	kBq	1,21E-11	1,21E-11	0,00E+00	0,00E+00	0,00E+00
(ar) Cobalt (Co58)	kBq	1,21E-11	1,21E-11	0,00E+00	0,00E+00	0,00E+00
(ar) Cobalt (Co60)	kBq	1,21042E-11	1,21E-11	0	0	0
(ar) Curium (Cm alpha)	kBq	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
(ar) Gas (unspecified)	kBq	3,03695E-05	3,04E-05	0	0	0
(ar) Iodine (I129)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Iodine (I131)	kBq	7,09E-11	7,09E-11	0,00E+00	0,00E+00	0,00E+00
(ar) Iodine (I133)	kBq	1,38E-10	1,38333E-10	0,00E+00	0,00E+00	0,00E+00
(ar) Krypton (Kr85)	kBq	1,84E-06	1,84E-06	0,00E+00	0,00E+00	0,00E+00
(ar) Lead (Pb210)	kBq	0,000226941	2,26E-04	1,29697E-06	0	0
(ar) Neptunium (Np237)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu alpha)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu214 beta XXX)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu238)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu239)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Polonium (Po210)	kBq	4,10E-04	4,08E-04	2,35E-06	0,00E+00	0,00E+00
(ar) Potassium (K40)	kBq	6,27708E-05	6,24E-05	3,58736E-07	0	0
(ar) Promethium (Pm147)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Protactinium (Pa234m)	kBq	1,71E-10	1,70965E-10	0,00E+00	0,00E+00	0,00E+00
(ar) Radioactive Substance (unspecified)	kBq	1,8557E-06	1,85E-06	1,05982E-08	0	0
(ar) Radium (Ra106)	kBq	0	0,00E+00	0	0	0
(ar) Radium (Ra222)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Radium (Ra226)	kBq	5,80E-05	5,76E-05	3,31E-07	0,00E+00	0,00E+00
(ar) Radium (Ra228)	kBq	3,14E-05	3,12E-05	1,79E-07	0,00E+00	0,00E+00
(ar) Radon (Rn220)	kBq	9,66E-04	9,60E-04	5,52E-06	0,00E+00	0,00E+00
(ar) Radon (Rn222)	kBq	4,12E-03	0,00394929	1,67E-04	0,00E+00	0,00E+00
(ar) Radon (Rn226)	kBq	0,00145355	1,45E-03	0	0	0
(ar) Strontium (Sr90)	kBq	0	0,00E+00	0	0	0
(ar) Technetium (Tc99)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Thorium (Th228)	kBq	2,66E-05	2,64E-05	1,52E-07	0,00E+00	0,00E+00
(ar) Thorium (Th230)	kBq	2,47E-09	2,47E-09	0,00E+00	0,00E+00	0,00E+00
(ar) Thorium (Th232)	kBq	1,69E-05	1,68E-05	9,66E-08	0,00E+00	0,00E+00
(ar) Thorium (Th234)	kBq	1,71E-10	1,70965E-10	0,00E+00	0,00E+00	0,00E+00
(ar) Tritium (H3)	kBq	3,68666E-06	3,69E-06	0	0	0
(ar) Uranium (U alpha)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(ar) Uranium (U234)	kBq	4,32E-09	4,32E-09	0,00E+00	0,00E+00	0,00E+00
(ar) Uranium (U235)	kBq	3,23E-11	3,23E-11	0,00E+00	0,00E+00	0,00E+00
(ar) Uranium (U238)	kBq	4,83E-05	4,80142E-05	2,76E-07	0,00E+00	0,00E+00
(ar) Xenon (Xe133)	kBq	2,58E-05	2,58E-05	0,00E+00	0,00E+00	0,00E+00
(s) Aluminium (Al)	g	2,52E-03	2,40E-03	1,14E-04	0,00E+00	6,16E-06
(s) Arsenic (As)	g	1,00499E-06	9,57E-07	4,56049E-08	0	2,45921E-09
(s) Atrazine (C8H14ClN5)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(s) Cadmium (Cd)	g	4,55E-10	4,33E-10	2,06E-11	0,00E+00	1,11E-12
(s) Calcium (Ca)	g	1,00E-02	9,57E-03	4,56E-04	0,00E+00	2,46E-05
(s) Carbon (C)	g	7,54E-03	7,18E-03	3,42E-04	0,00E+00	1,85E-05
(s) Chromium (Cr III, Cr VI)	g	1,26E-05	1,20E-05	5,71E-07	0,00E+00	3,08E-08
(s) Cobalt (Co)	g	4,61E-10	4,39E-10	2,09E-11	0,00E+00	1,13E-12
(s) Copper (Cu)	g	2,30839E-09	2,20E-09	1,04751E-10	0	5,64861E-12
(s) Hydrocarbons (unspecified)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(s) Iron (Fe)	g	5,02E-03	4,78E-03	2,28E-04	0,00E+00	1,23E-05
(s) Lead (Pb)	g	1,06E-08	1,00E-08	4,79E-10	0,00E+00	2,58E-11
(s) Manganese (Mn)	g	1,00E-04	9,57E-05	4,56E-06	0,00E+00	2,46E-07
(s) Mercury (Hg)	g	8,38E-11	7,97E-11	3,80E-12	0,00E+00	2,05E-13
(s) Nickel (Ni)	g	3,47E-09	3,30E-09	1,57E-10	0,00E+00	8,48E-12
(s) Nitrogen (N)	g	3,94E-08	3,75E-08	1,79E-09	0,00E+00	9,64E-11
(s) Oils (unspecified)	g	1,49E-05	1,42E-05	6,77E-07	0,00E+00	3,65E-08
(s) Phosphorus (P)	g	1,26E-04	1,20E-04	5,71E-06	0,00E+00	3,08E-07
(s) Sulphur (S)	g	1,51E-03	1,44E-03	6,84E-05	0,00E+00	3,69E-06
(s) Zinc (Zn)	g	3,78E-05	3,59631E-05	1,71E-06	0,00E+00	9,24E-08
(sr) Americium (Am241)	kBq	3,18E-06	3,18451E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Americium (Am243)	kBq	6,94E-08	6,93524E-08	0,00E+00	0,00E+00	0,00E+00
(sr) Cesium (Cs135)	kBq	1,55E-03	1,55E-03	0,00E+00	0,00E+00	0,00E+00
(sr) Cesium (Cs137)	kBq	4,34E-09	4,34095E-09	0,00E+00	0,00E+00	0,00E+00
(sr) Curium (Cm244)	kBq	6,46E-06	6,46E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Curium (Cm245)	kBq	7,21E-10	7,21E-10	0,00E+00	0,00E+00	0,00E+00
(sr) Iodine (I129)	kBq	1,02E-10	1,02E-10	0,00E+00	0,00E+00	0,00E+00
(sr) Neptunium (Np237)	kBq	9,98E-07	9,98E-07	0,00E+00	0,00E+00	0,00E+00
(sr) Palladium (Pd107)	kBq	3,50E-10	3,50164E-10	0,00E+00	0,00E+00	0,00E+00
(sr) Plutonium (Pu239)	kBq	1,21E-03	0,00120729	0	0	0
(sr) Plutonium (Pu240)	kBq	0,00171804	0,00171804	0	0	0
(sr) Plutonium (Pu241)	kBq	3,98E-01	0,397775	0,00E+00	0,00E+00	0,00E+00

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(sr) Plutonium (Pu242)	kBq	6,49E-06	6,48619E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Radium (Ra226)	kBq	8,24E-06	8,24E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Samarium (Sm151)	kBq	1,44E-06	1,44E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Selenium (Se79)	kBq	1,12E-09	1,11939E-09	0,00E+00	0,00E+00	0,00E+00
(sr) Strontium (Sr90)	kBq	2,32E-04	0,000232049	0,00E+00	0,00E+00	0,00E+00
(sr) Technetium (Tc99)	kBq	4,74E-08	4,74195E-08	0,00E+00	0,00E+00	0,00E+00
(sr) Thorium (Th230)	kBq	8,24E-06	8,24E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Tin (Sn126)	kBq	1,9581E-09	1,96E-09	0	0	0
(sr) Uranium (U233)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(sr) Uranium (U234)	kBq	5,12E-06	5,12E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Uranium (U235)	kBq	9,24E-08	9,24E-08	0,00E+00	0,00E+00	0,00E+00
(sr) Uranium (U238)	kBq	1,43E-06	1,43185E-06	0,00E+00	0,00E+00	0,00E+00
(sr) Zirconium (Zr93)	kBq	6,23283E-09	6,23283E-09	0,00E+00	0,00E+00	0,00E+00
(w) Acids (H+)	g	7,99E-01	7,80E-01	4,39E-06	1,50E-02	4,08E-03
(w) Alcohol (unspecified)	g	2,16E-07	1,27E-09	0,00E+00	0,00E+00	2,15E-07
(w) Aldehyde (unspecified)	g	1,08E-06	1,02E-06	4,88E-08	0,00E+00	2,63E-09
(w) Alkane (unspecified)	g	5,20E-03	1,79E-03	3,37E-03	0,00E+00	5,16E-05
(w) Alkene (unspecified)	g	4,80E-04	0,000164836	3,11E-04	0,00E+00	4,76E-06
(w) Aluminium (Al3+)	g	5,89E-03	5,13E-03	1,14E-04	2,31E-04	4,07E-04
(w) Aluminium Hydroxide (Al(OH)3)	g	3,77E-09	1,47478E-11	0,00E+00	0,00E+00	3,75E-09
(w) Ammonia (NH4+, NH3, as N)	g	9,22E-02	1,20E-02	2,21E-02	1,47E-02	4,34E-02
(w) AOX (Adsorbable Organic Halogens)	g	1,55E-03	5,17E-05	5,49E-05	1,45E-03	9,39E-07
(w) Aromatic Hydrocarbons (unspecified)	g	2,09E-02	7,24E-03	1,35E-02	0,00E+00	2,07E-04
(w) Arsenic (As3+, As5+)	g	2,80E-05	1,33E-05	1,09E-05	2,78E-07	3,61E-06
(w) Barium (Ba++)	g	1,00E-01	0,0340695	6,48E-02	0,00E+00	1,10E-03
(w) Barytes	g	3,56E-02	3,39E-02	1,62E-03	0,00E+00	8,72E-05
(w) Benzene (C6H6)	g	0,00520548	0,00178672	0,00336703	6,57218E-11	5,17335E-05
(w) BOD5 (Biochemical Oxygen Demand)	g	1,06E+00	8,89E-01	1,18E-03	1,50E-01	1,90E-02
(w) Boric Acid (H3BO3)	g	4,39E-06	1,88E-08	0,00E+00	0,00E+00	4,37E-06
(w) Boron (B III)	g	6,49E-04	2,23E-04	4,20E-04	0,00E+00	6,44E-06
(w) Bromates (BrO3-)	g	4,81E-04	4,04E-05	0,00E+00	4,40E-04	0,00E+00
(w) Cadmium (Cd++)	g	2,73483E-05	7,8419E-06	1,81279E-05	1,04783E-08	1,36803E-06
(w) Calcium (Ca++)	g	1,66E+00	4,47E-01	8,32E-01	3,67E-01	1,28E-02
(w) Carbonates (CO3--, HCO3-, CO2, as C)	g	1,64E-01	2,69E-04	3,77E-08	1,64E-01	3,87E-06
(w) Cerium (Ce++)	g	3,97E-05	1,35E-05	2,58E-05	0,00E+00	3,46E-07
(w) Cesium (Cs++)	g	4,99E-08	0,00E+00	0,00E+00	0,00E+00	4,99E-08

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(w) Chlorates (ClO3-)	g	0,256387	0,00108889	0	0,255299	0
(w) Chlorides (Cl-)	g	7,39E+01	1,09E+01	1,34E+01	4,90E+01	5,89E-01
(w) Chlorinated Matter (unspecified, as Cl)	g	5,67E-03	5,40E-03	2,57E-04	0,00E+00	1,39E-05
(w) Chlorine (Cl2)	g	3,41E-03	4,24E-05	7,37E-09	3,37E-03	0,00E+00
(w) Chloroform (CHCl3, HC-20)	g	6,08E-09	5,79E-09	2,76E-10	0,00E+00	1,49E-11
(w) Chromate (CrO4--)	g	8,57E-07	8,56E-07	8,15E-10	0,00E+00	0,00E+00
(w) Chromites (CrO3-)	g	2,43E-05	2,43E-05	2,19E-11	0,00E+00	0,00E+00
(w) Chromium (Cr III)	g	2,64E-05	2,52E-05	1,20E-06	0,00E+00	6,88E-08
(w) Chromium (Cr III, Cr VI)	g	1,18E-04	3,32E-05	6,25E-05	3,25E-09	2,25E-05
(w) Chromium (Cr VI)	g	4,96E-10	4,73E-10	2,25E-11	0,00E+00	1,21E-12
(w) Cobalt (Co I, Co II, Co III)	g	1,63113E-06	1,55312E-06	7,40176E-08	0	3,99136E-09
(w) COD (Chemical Oxygen Demand)	g	1,98E+01	5,33E+00	3,89E-02	1,43E+01	1,04E-01
(w) Copper (Cu+, Cu++)	g	1,78E-03	4,99E-05	3,69E-05	1,69E-03	2,42E-06
(w) Cyanide (CN-)	g	4,95E-04	4,36E-04	5,74E-05	8,79E-08	1,81E-06
(w) Dichloroethane (1,2-CH2ClCH2Cl)	g	0,00217149	2,43E-05	0,00E+00	2,15E-03	0,00E+00
(w) Dioxins (unspecified)	g	6,98906E-06	0	0	6,98906E-06	0
(w) Dissolved Matter (unspecified)	g	2,20E+01	4,09E-01	1,14E-03	2,16E+01	8,92E-04
(w) Dissolved Organic Carbon (DOC)	g	2,01E-03	1,91E-03	9,10E-05	0,00E+00	5,22E-06
(w) Edetic Acid (EDTA, C10H16N2O8)	g	7,46E-09	3,20E-11	0,00E+00	0,00E+00	7,42E-09
(w) Ethyl Benzene (C6H5C2H5)	g	9,57E-04	3,25E-04	6,21E-04	0,00E+00	9,90E-06
(w) Fluorides (F-)	g	1,31E-03	1,03E-03	2,76E-04	5,35E-06	6,84E-06
(w) Formaldehyde (CH2O)	g	7,70E-11	7,34E-11	3,49622E-12	0	1,88532E-13
(w) Halogenated Matter (organic)	g	5,78E-18	5,78E-18	0,00E+00	0,00E+00	0,00E+00
(w) Hexachloroethane (C2Cl6)	g	1,07E-14	1,02E-14	4,87E-16	0,00E+00	2,62E-17
(w) Hydrazine (N2H4)	g	3,43E-09	1,47E-11	0,00E+00	0,00E+00	3,41E-09
(w) Hydrocarbons (unspecified)	g	4,51E-03	4,21E-04	7,39E-08	3,87E-03	2,21E-04
(w) Hypochlorite (ClO-)	g	1,83E-06	1,74E-06	8,29E-08	0,00E+00	4,47E-09
(w) Hypochlorous Acid (HClO)	g	1,83E-06	1,74E-06	8,29E-08	0,00E+00	4,47E-09
(w) Inorganic Dissolved Matter (unspecified)	g	4,21E-06	1,60E-06	2,12E-06	0,00E+00	4,88E-07
(w) Iode (I-)	g	3,98E-03	0,00135369	2,59E-03	0,00E+00	3,96E-05
(w) Iron (Fe++, Fe3+)	g	8,33E-03	3,17E-03	3,19E-03	5,15E-04	1,45E-03
(w) Lead (Pb++, Pb4+)	g	7,78E-05	4,55E-05	1,15E-05	7,53E-06	1,32E-05
(w) Lithium Salts (Lithine)	g	3,83E-10	1,64271E-12	0,00E+00	0,00E+00	3,81E-10
(w) Magnesium (Mg++)	g	3,47E-02	1,23E-02	2,16E-02	5,56E-04	3,46E-04
(w) Manganese (Mn II, Mn IV, Mn VII)	g	2,14E-03	8,63E-04	1,25E-03	4,86E-08	2,62E-05
(w) Mercury (Hg+, Hg++)	g	4,86E-05	2,52473E-05	1,08399E-07	2,31857E-05	9,56161E-08

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(w) Metals (unspecified)	g	5,54E-02	1,15E-02	1,61E-06	4,36E-02	2,62E-04
(w) Methane (CH4)	g	1,00167E-05	0,00E+00	0	0	1,00166E-05
(w) Methyl tert Butyl Ether (MTBE, C5H12O)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(w) Methylene Chloride (CH2Cl2, HC-130)	g	2,70E-05	1,66E-05	7,91E-07	0,00E+00	9,62E-06
(w) Molybdenum (Mo II, Mo III, Mo IV, Mo V, Mo VI)	g	1,68E-05	5,63E-06	1,08E-05	0,00E+00	4,05E-07
(w) Morpholine (C4H9NO)	g	3,63E-08	1,56E-10	0,00E+00	0,00E+00	3,61E-08
(w) Nickel (Ni++, Ni3+)	g	1,27E-03	8,26439E-05	6,29088E-05	0,00112371	2,9134E-06
(w) Nitrate (NO3-)	g	1,03E-01	5,69E-02	3,88E-02	6,54E-03	6,11E-04
(w) Nitrite (NO2-)	g	4,53E-07	4,31E-07	2,06E-08	0,00E+00	1,11E-09
(w) Nitrogenous Matter (Kjeldahl, as N)	g	1,53E-06	7,44E-09	0,00E+00	0,00E+00	1,52E-06
(w) Nitrogenous Matter (unspecified, as N)	g	2,96E-02	0,00643401	0,00552963	0,0175602	9,43477E-05
(w) Oils (unspecified)	g	0,0527062	1,98E-02	0,021935	0,00888855	0,0021221
(w) Organic Dissolved Matter (aliphatic)	g	0	0,00E+00	0	0	0
(w) Organic Dissolved Matter (aromatic)	g	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
(w) Organic Dissolved Matter (chlorinated)	g	0,000748397	8,55E-05	9,31862E-09	0,000662879	3,08804E-10
(w) Organic Dissolved Matter (unspecified)	g	2,10E-02	0,000590271	3,08E-08	2,05E-02	2,35E-07
(w) Organic Matter (unspecified)	g	0,166859	2,52E-05	9,93E-10	1,67E-01	0,00E+00
(w) Organo-silicon (unspecified)	g	2,56898E-17	0,00E+00	0,00E+00	2,57E-17	0,00E+00
(w) Organo-tin as Sn (unspecified)	g	1,01E-05	0,00E+00	0,00E+00	1,01E-05	0,00E+00
(w) Oxalic Acid ((COOH)2)	g	1,49E-08	6,40E-11	0,00E+00	0,00E+00	1,48E-08
(w) Phenol (C6H5OH)	g	7,86E-03	0,00426444	2,99E-03	5,58E-04	4,61E-05
(w) Phosphates (PO4 3-, HPO4--, H2PO4-, H3PO4, as P)	g	1,19E-03	6,60E-04	6,62952E-07	0	0,000528759
(w) Phosphorous Matter (unspecified, as P)	g	3,39E-02	6,49E-06	0,00E+00	3,39E-02	0,00E+00
(w) Phosphorus (P)	g	1,60E-04	5,04E-05	1,08E-04	0,00E+00	1,65E-06
(w) Phosphorus Pentoxide (P2O5)	g	9,13E-06	9,06E-06	5,20E-08	0,00E+00	2,27E-08
(w) Polycyclic Aromatic Hydrocarbons (PAH, unspecified)	g	0,000587034	2,45E-04	0,000336494	0	5,1717E-06
(w) Polycyclic Aromatic Hydrocarbons (unspecified)	g	0	0	0	0	0
(w) Potassium (K+)	g	2,23E-01	7,19E-02	1,14E-01	3,46E-02	1,75E-03
(w) Rubidium (Rb+)	g	3,98E-04	0,000135353	2,59E-04	0,00E+00	3,96E-06
(w) Salts (unspecified)	g	0,00746897	5,89E-03	6,11E-05	0,00E+00	1,52E-03
(w) Saponifiable Oils and Fats	g	1,94E-01	6,61E-02	1,26E-01	0,00E+00	1,93E-03
(w) Selenium (Se II, Se IV, Se VI)	g	1,68E-05	5,63E-06	1,08E-05	0,00E+00	3,74E-07

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(w) Silicon Dioxide (SiO2)	g	6,25E-06	5,95E-06	2,84E-07	0,00E+00	1,53E-08
(w) Silver (Ag+)	g	2,38883E-05	8,12115E-06	1,55293E-05	0	2,37844E-07
(w) Sodium (Na+)	g	41,5517	5,05066	8,08E+00	2,83E+01	1,31E-01
(w) Strontium (Sr II)	g	0,240712	0,0824887	0,155777	5,77313E-05	0,00238828
(w) Sulphate (SO4--)	g	4,09E+00	2,78E-01	2,16E-01	3,53E+00	6,77E-02
(w) Sulphide (S--)	g	8,73E-04	2,46E-04	4,20E-04	2,01E-04	6,46E-06
(w) Sulphite (SO3--)	g	3,87E-08	2,86E-08	1,36E-09	0,00E+00	8,74E-09
(w) Sulphurated Matter (unspecified, as S)	g	7,24E-09	2,26E-09	4,88173E-09	0	9,62157E-11
(w) Suspended Matter (organic)	g	1,04003E-10	1,04003E-10	0	0	0
(w) Suspended Matter (unspecified)	g	8,12E+00	1,13E+00	6,83E-03	6,97E+00	8,85E-03
(w) Tars (unspecified)	g	6,98E-09	4,75E-09	2,19E-09	0,00E+00	3,88E-11
(w) Tetrachloroethylene (C2Cl4)	g	1,04E-07	2,50E-11	1,19E-12	0,00E+00	1,04E-07
(w) Tin (Sn++, Sn4+)	g	8,25E-10	4,37E-12	0,00E+00	0,00E+00	8,20E-10
(w) Titanium (Ti3+, Ti4+)	g	6,56885E-05	6,24241E-05	2,97493E-06	0	2,89531E-07
(w) TOC (Total Organic Carbon)	g	3,28E-01	1,22E-01	1,90E-01	1,20E-02	2,99E-03
(w) Toluene (C6H5CH3)	g	4,33E-03	1,49E-03	2,80E-03	0,00E+00	4,78E-05
(w) Tributyl Phosphate ((C4H9)3PO4, TBP)	g	1,41E-07	0,00E+00	0,00E+00	0,00E+00	1,41E-07
(w) Trichloroethane (1,1,1-CH3CCl3)	g	5,91E-11	5,63E-11	2,68E-12	0,00E+00	1,45E-13
(w) Trichloroethylene (CCl2CHCl)	g	1,30E-07	1,55E-09	7,38E-11	0,00E+00	1,28E-07
(w) Triethylene Glycol (C6H14O4)	g	2,01E-03	1,91E-03	9,10E-05	0,00E+00	4,91E-06
(w) Vanadium (V3+, V5+)	g	1,74E-05	5,63E-06	1,08E-05	0,00E+00	9,84E-07
(w) Vinyl Chloride (CH2CHCl)	g	1,02E-02	2,43E-05	3,30E-11	1,01E-02	0,00E+00
(w) VOC (Volatile Organic Compounds)	g	0,0139091	0,0047286	0,00904201	0	0,000138486
(w) Water (unspecified)	litre	0,287721	0,285332	0,00165232	0	0,000737348
(w) Water: Chemically Polluted	litre	1,27324	0,924903	0,0454626	0	0,302879
(w) Water: Thermally Polluted (only)	litre	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(w) Xylene (C6H4(CH3)2)	g	3,71E-02	1,27E-02	2,43E-02	0,00E+00	0,00E+00
(w) Zinc (Zn++)	g	0,000415628	1,44E-04	0,000109754	8,13292E-05	8,08125E-05
(wr) Americium (Am241)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Antimony (Sb124)	kBq	7,17604E-10	7,18E-10	0	0	0
(wr) Antimony (Sb125)	kBq	0	0,00E+00	0	0	0
(wr) Carbon (C14)	kBq	0	0,00E+00	0	0	0
(wr) Cerium (Ce144)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Cesium (Cs134)	kBq	6,31E-10	6,31E-10	0,00E+00	0,00E+00	0,00E+00
(wr) Cesium (Cs137)	kBq	9,25E-10	9,25E-10	0,00E+00	0,00E+00	0,00E+00
(wr) Cobalt (Co58)	kBq	2,08E-09	2,08E-09	0,00E+00	0,00E+00	0,00E+00

Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
(wr) Cobalt (Co60)	kBq	1,29687E-09	1,30E-09	0	0	0
(wr) Curium (Cm alpha)	kBq	0	0,00E+00	0	0	0
(wr) Curium (Cm244)	kBq	0	0,00E+00	0	0	0
(wr) Iodine (I129)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Iodine (I131)	kBq	7,87E-11	7,87E-11	0,00E+00	0,00E+00	0,00E+00
(wr) Manganese (Mn54)	kBq	1,0375E-10	1,04E-10	0	0	0
(wr) Manganese (Mn55)	kBq	0	0,00E+00	0	0	0
(wr) Mix (Zr95, Nb95)	kBq	0	0,00E+00	0	0	0
(wr) Neptunium (Np237)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu alpha XXX)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu238)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu239)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu241 beta)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Protactinium (Pa234m)	kBq	3,17E-09	3,16602E-09	0,00E+00	0,00E+00	0,00E+00
(wr) Radioactive Substance (unspecified)	kBq	1,71E-08	1,70E-08	9,75E-11	0,00E+00	0,00E+00
(wr) Radium (Ra224)	kBq	1,97E-03	0,000676764	1,29E-03	0,00E+00	0,00E+00
(wr) Radium (Ra226)	kBq	3,95E-03	1,36E-03	2,59E-03	0,00E+00	0,00E+00
(wr) Radium (Ra228)	kBq	0,00394175	1,35E-03	0,00258822	0	0
(wr) Ruthenium (Ru106)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Silver (Ag110m)	kBq	3,1125E-09	3,11E-09	0	0	0
(wr) Strontium (Sr90)	kBq	0	0,00E+00	0	0	0
(wr) Technetium (Tc99)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Thorium (Th228)	kBq	7,88E-03	2,71E-03	5,18E-03	0,00E+00	0,00E+00
(wr) Thorium (Th230)	kBq	2,96E-07	2,96E-07	0,00E+00	0,00E+00	0,00E+00
(wr) Thorium (Th234)	kBq	3,17E-09	3,16602E-09	0,00E+00	0,00E+00	0,00E+00
(wr) Tritium (H3)	kBq	3,77797E-05	3,78E-05	0	0	0
(wr) Uranium (U alpha XXX)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Uranium (U234)	kBq	1,05E-07	1,05E-07	0,00E+00	0,00E+00	0,00E+00
(wr) Uranium (U235)	kBq	4,54E-09	4,54E-09	0,00E+00	0,00E+00	0,00E+00
(wr) Uranium (U238)	kBq	9,81025E-08	9,81025E-08	0	0	0
Hydrochloric Acid (HCl, 100%)	kg	8,04E-05	8,04065E-05	0,00E+00	0,00E+00	0,00E+00
Recovered Energy	MJ	8,24E-01	0	0,00E+00	8,24E-01	0,00E+00
Recovered Energy (total)	MJ	0,823551	0,00E+00	0	0,823551	0
Recovered Matter (total)	kg	8,77E-02	0,0868676	5,16878E-06	0,000695762	0,000100477
Recovered Matter (unspecified)	kg	7,06E-02	6,98E-02	5,17E-06	6,96E-04	1,07E-04
Recovered Matter: Ash	kg	0,00E+00	0	0	0	0

	Flow	Units	Cork	Cork stoppers production	Transport	Bottling	End of life
	Recovered Matter: Cardboard	kg	0,0170823	1,71E-02	0	0	0
	Recovered Matter: Iron Scrap	kg	8,84837E-08	3,72598E-10	0	0	8,81111E-08
	Recovered Matter: Metals (unspecified)	kg	0,0374575	3,75E-02	0	0	0
	Recovered Matter: Non Ferrous Metals	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Others for Energy	kg	0,599428	5,99E-01	0	0	0
	Recovered Matter: Paraffin Wax	kg	0	0,00E+00	0	0	0
	Recovered Matter: Steel Scrap	kg	6,25625E-06	0,00E+00	0	0	6,25625E-06
	Recovered Matter: Tall Oil	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Turpentine	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Silica (SiO2)	kg	0	0	0	0	0
	Waste (hazardous)	kg	0,00440629	3,21E-04	0,000258235	0,00382311	4,11176E-06
	Waste (incineration)	kg	2,02E-05	0,00E+00	0,00E+00	0,00E+00	2,02E-05
	Waste (municipal and industrial)	kg	0,173729	0,178408	2,68824E-07	-0,0047738	9,47856E-05
	Waste (municipal and industrial, to incineration)	kg	0,00E+00	0,00E+00	0	0	0
	Waste (tailings)	kg	4,09E-03	4,04E-08	0,00E+00	4,09E-03	0,00E+00
	Waste (total)	kg	3,72E+00	3,10E-01	1,71E-03	7,29E-02	3,33E+00
	Waste (unspecified)	kg	1,25E-02	7,04E-04	3,54E-05	1,17E-02	2,79E-05
	Waste (unspecified, to incineration)	kg	4,65E-03	8,98E-05	1,43E-04	4,41E-03	0,00E+00
	Waste: Highly Radioactive (class C)	kg	8,79859E-09	9,19E-11	0,00E+00	0,00E+00	8,71E-09
	Waste: Intermediate Radioactive (class B)	kg	6,65E-08	0,00E+00	0	0	6,64975E-08
	Waste: Low Radioactive (class A)	kg	0,000243566	8,25659E-05	0,000157876	0	3,12354E-06
	Waste: Mineral (inert)	kg	1,14E-01	9,94E-02	9,77E-04	9,07E-03	4,86E-03
	Waste: Mining	kg	0,000744882	4,77E-06	0	0	0,000740117
	Waste: Non Mineral (inert)	kg	3,33E+00	8,71E-06	1,88E-05	0,00E+00	3,33E+00
	Waste: Non Toxic Chemicals (unspecified)	kg	1,06E-02	7,73E-04	8,59976E-09	0,009862	5,85189E-06
	Waste: Radioactive	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Waste: Radioactive (unspecified)	kg	3,72252E-05	1,16548E-05	2,51847E-05	0	3,85721E-07
	Waste: Slags and Ash (unspecified)	kg	0,0585646	0,0237511	0,000094956	0,0346794	3,91412E-05
	Waste: Treatment	kg	0,00004501	0	0	0	0,00004501
Reminders:	E Feedstock Energy	MJ	24,2724	0,221931	-0,00144467	24,0122	0,0396907
	E Fuel Energy	MJ	91,095	34,2208	11,479	45,0781	0,317031
	E Non Renewable Energy	MJ	102,019	22,8192	11,4673	67,3814	0,351249
	E Renewable Energy	MJ	13,3477	11,623	0,0102292	1,70899	0,00541177
	E Total Primary Energy	MJ	115,367	34,4428	11,4775	69,0904	0,356713
	Electricity	MJ elec	6,70667	6,64487	0,0312774	0	0,030517

Table 22: Inventory of the natural cork stoppers LCA

	Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
Inputs:	(r) Barium Sulphate (BaSO4, in ground)	kg	0,000645313	0,000639258	3,79958E-06	0	2,25527E-06
	(r) Bauxite (Al2O3, ore)	kg	1,10E+01	1,10E+01	3,36E-06	0,00E+00	4,00E-07
	(r) Bentonite (Al2O3.4SiO2.H2O, in ground)	kg	1,88E-04	8,53622E-05	3,59E-07	0,00E+00	1,02E-04
	(r) Calcium Sulphate (CaSO4, ore)	kg	1,90E-05	5,91E-06	6,25E-07	0,00E+00	1,24E-05
	(r) Carbon Dioxide (CO2, in ground)	kg	6,35E-05	6,35E-05	0,00E+00	0,00E+00	0,00E+00
	(r) Chromium (Cr, ore)	kg	1,24E-07	1,23E-07	7,30E-10	0,00E+00	8,22E-11
	(r) Clay (in ground)	kg	1,83E+00	2,99E-04	4,41E-06	0,00E+00	1,83E+00
	(r) Coal (in ground)	kg	4,21148	4,20999	0,000557015	0	0,00093375
	(r) Copper (Cu, ore)	kg	2,09E-06	2,08E-06	3,72E-09	0,00E+00	4,19E-10
	(r) Dolomite (CaCO3.MgCO3, in ground)	kg	7,07E-06	7,07E-06	5,78E-13	0,00E+00	0,00E+00
	(r) Feldspar (ore)	kg	9,80E-09	9,80E-09	0,00E+00	0,00E+00	0,00E+00
	(r) Ferromanganese (Fe, Mn, C; Ore)	kg	1,35E-07	1,35E-07	7,91E-16	0,00E+00	0,00E+00
	(r) Fluorspar (CaF2, ore)	kg	7,87E-02	7,87E-02	0,00E+00	0,00E+00	0,00E+00
	(r) Granite (in ground)	kg	9,80E-09	9,80E-09	0,00E+00	0,00E+00	0,00E+00
	(r) Gravel (unspecified)	kg	5,79E-04	4,88E-04	8,55E-05	0,00E+00	5,12E-06
	(r) Iron (Fe, ore)	kg	1,41E-02	1,39E-02	1,15E-05	0,00E+00	1,67E-04
	(r) Iron Sulphate (FeSO4, ore)	kg	3,67E-06	3,63E-06	1,76E-08	0,00E+00	2,11E-08
	(r) Lead (Pb, ore)	kg	7,36E-07	7,35E-07	1,16E-09	0,00E+00	1,31E-10
	(r) Lignite (in ground)	kg	3,57E+00	3,57E+00	1,90E-04	0,00E+00	2,43E-05
	(r) Limestone (CaCO3, in ground)	kg	0,50845	0,508035	2,81418E-05	0	0,00038777
	(r) Magnesium (Mg, ore)	kg	4,60E-19	4,60E-19	0,00E+00	0,00E+00	0,00E+00
	(r) Manganese (Mn, ore)	kg	6,65E-08	6,60E-08	4,25E-10	0,00E+00	4,78E-11
	(r) Mercury (Hg, ore)	kg	2,14E-07	2,14E-07	0,00E+00	0,00E+00	0,00E+00
	(r) Natural Gas (in ground)	kg	1,79519	1,79E+00	2,85E-03	0,00E+00	6,27E-04
	(r) Nickel (Ni, ore)	kg	4,99E-08	4,96E-08	2,47E-10	0,00E+00	2,78E-11
	(r) Oil (in ground)	kg	4,13E+00	4,01E+00	1,15E-01	0,00E+00	4,87E-03
	(r) Olivine ((Mg,Fe)2SiO4, ore)	kg	1,37E-06	1,37E-06	6,54554E-14	0	0
	(r) Peat (in ground)	kg	6,30E-05	6,30E-05	0,00E+00	0,00E+00	0,00E+00
	(r) Perlite (SiO2, ore)	kg	3,32E-02	3,32E-02	0,00E+00	0,00E+00	0,00E+00
	(r) Phosphate Rock (in ground)	kg	0,00231517	5,78E-04	0	0	0,00173721
	(r) Potassium Chloride (KCl, as K2O, in ground)	kg	9,69E-03	9,69E-03	1,41E-08	0,00E+00	0,00E+00
	(r) Pyrite (FeS2, ore)	kg	9,52E-04	9,45E-04	6,09E-06	0,00E+00	6,86E-07
	(r) Quartzite (SiO2, in ground)	kg	1,53E-23	1,53E-23	0,00E+00	0,00E+00	0,00E+00
	(r) Rutile (TiO2, ore)	kg	7,16551E-33	7,17E-33	0,00E+00	0,00E+00	0,00E+00
	(r) Sand (in ground)	kg	0,271644	2,03E-04	1,52E-06	0,00E+00	2,71E-01

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(r) Silver (Ag, ore)	kg	2,88E-09	2,86E-09	1,84E-11	0,00E+00	2,07E-12
(r) Sodium Chloride (NaCl, in ground or in sea)	kg	3,13E-01	3,13E-01	1,58E-05	0,00E+00	1,35E-05
(r) Sodium Nitrate (NaNO3)	kg	1,38306E-18	1,38E-18	0,00E+00	0,00E+00	0,00E+00
(r) Sulphur (in natural gas)	kg	0,0116412	1,15E-02	0,00E+00	0,00E+00	1,73E-04
(r) Sulphur (S, in ground)	kg	7,88E-05	7,88E-05	9,88E-10	0,00E+00	2,27E-10
(r) Talcum (4SiO2.3MgO.H2O, ore)	kg	5,20E-03	5,20E-03	0,00E+00	0,00E+00	0,00E+00
(r) Tin (Sn, ore)	kg	3,65E-04	3,65E-04	0,00E+00	0,00E+00	0,00E+00
(r) Titanium (Ti, ore)	kg	8,02E-09	8,02E-09	0,00E+00	0,00E+00	0,00E+00
(r) Uranium (U, ore)	kg	2,34E-04	2,34E-04	2,58E-08	0,00E+00	1,10E-07
(r) Wood (standing)	kg	1,06E-04	1,03E-04	2,87E-06	0,00E+00	0,00E+00
(r) Wood (standing, in kg)	kg	9,80E-05	9,80E-05	0,00E+00	0,00E+00	0,00E+00
(r) Wood (standing, kg)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(r) Zinc (Zn, ore)	kg	3,39E-08	3,38E-08	2,70E-11	0,00E+00	3,04E-12
(w) Phosphorous Matter (unspecified, as P)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
_(a) Carbon dioxyde (from air, sink effect)	g	0,00E+00	0	0	0	0
_(r) Cork Standing	kg	0	0	0	0	0
_Biofuel	MJ	0,027372	2,74E-02	0	0	0
Adjuvant (unspecified)	kg	6,12E-10	6,12E-10	0	0	0
Alloy (unspecified)	kg	0,140754	0,140754	0	0	0
Amine (unspecified)	kg	1,06586E-10	1,06586E-10	0	0	0
Antifoaming Agent (unspecified)	kg	2,28E-05	2,28E-05	0	0	0
Biocide (unspecified)	kg	9,124E-08	9,12E-08	0	0	0
Biomass (unspecified)	kg	0,0150899	1,51E-02	0	0	0
Catalyst (unspecified)	kg	6,92E-11	6,92E-11	0	0	0
Detergent Agent (unspecified)	kg	3,86E-04	3,86E-04	0	0	0
Dewaxing Agent (unspecified)	kg	3,39498E-09	3,39E-09	0	0	0
Explosive (unspecified)	kg	4,78E-05	4,73E-05	2,10236E-07	0	2,7268E-07
Ferromanganese (Fe, Mn, C)	kg	2,03E-09	2,03E-09	0,00E+00	0,00E+00	0,00E+00
Furfural (C5H4O2)	kg	7,94E-09	7,94E-09	0,00E+00	0,00E+00	0,00E+00
Iron Scrap	kg	1,09E-01	1,09E-01	9,50936E-05	0	2,39797E-05
Land Use (II -> III)	m2a	4,81E-04	0,000478237	3,15E-06	0,00E+00	0,00E+00
Land Use (II -> IV)	m2a	6,47E-05	6,41E-05	5,52E-07	0,00E+00	0,00E+00
Land Use (III -> IV)	m2a	2,29E-05	2,27E-05	1,87E-07	0,00E+00	0,00E+00
Maize	kg	2,61E-06	2,61E-06	0,00E+00	0,00E+00	0,00E+00
Peat	kg	3,53369E-06	3,53E-06	0	0	0
Potatoes	kg	1,65E-08	1,65E-08	0,00E+00	0,00E+00	0,00E+00

	Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
	Raw Materials (unspecified)	kg	0,0610814	6,10E-02	8,67855E-05	0	2,42899E-05
	Recovered Matter (total)	kg	1,83E+00	1,83E+00	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Aluminium Scrap	kg	1,82236	1,82E+00	0	0	0
	Recovered Matter: Iron Scrap	kg	0	0	0	0	0
	Recovered Matter: Others for Energy	kg	0	0,00E+00	0	0	0
	Recovered Matter: Paper, Cardboard	kg	0,00581655	5,82E-03	0	0	0
	Sodium Hydrocarbonate (NaHCO3)	kg	1,32298E-06	1,32E-06	0	0	0
	Solvent (unspecified)	kg	1,51E-09	1,51E-09	0	0	0
	Steel	kg	0,0135956	1,36E-02	0	0	0
	Trinitrotoluene (C6H2CH3(NO2)3)	kg	3,16719E-06	3,17E-06	0	0	0
	Urea (H2NCONH2)	kg	1,08348E-09	1,08348E-09	0	0	0
	Water Used (total)	litre	13,4786	1,29E+01	0,475381	0	0,122846
	Water: Ground	litre	0,00771615	0,00771615	0	0	0
	Water: Public Network	litre	1,46654	1,46653	1,32266E-06	0	6,01819E-06
	Water: River	litre	1,24476	1,24476	5,70417E-11	0	0
	Water: Sea	litre	0,119365	0,119365	6,12685E-09	0	0
	Water: Unspecified Origin	litre	10,6389	1,00E+01	0,47538	0	0,122846
	Water: Well	litre	1,31E-03	1,31E-03	3,03E-11	0,00E+00	0,00E+00
	Wood	kg	0,00179761	1,79E-03	1,27254E-07	0	5,83206E-06
	Wood (standing, maritime pine)	m3	9,57E-05	9,57E-05	0,00E+00	0,00E+00	0,00E+00
Outputs:	(a) Acetaldehyde (CH3CHO)	g	1,93E-04	1,92E-04	5,72E-07	0,00E+00	1,95E-07
	(a) Acetic Acid (CH3COOH)	g	2,89E-03	2,87E-03	1,60E-05	0,00E+00	2,19E-06
	(a) Acetone (CH3COCH3)	g	1,80E-04	1,79E-04	4,89E-07	0,00E+00	1,87E-07
	(a) Acetylene (C2H2)	g	4,04E-04	3,84E-04	1,32E-05	0,00E+00	6,11E-06
	(a) Aldehyde (unspecified)	g	1,25E-03	1,24E-03	2,46E-07	0,00E+00	7,29E-07
	(a) Alkane (unspecified)	g	4,76E-02	4,50E-02	2,35E-03	0,00E+00	2,46E-04
	(a) Alkene (unspecified)	g	5,72E-04	5,52E-04	1,39E-05	0,00E+00	6,20E-06
	(a) Alkyne (unspecified)	g	9,69E-07	9,62E-07	6,20E-09	0,00E+00	6,98E-10
	(a) Aluminium (Al)	g	7,16E-03	6,93E-03	1,11E-04	0,00E+00	1,13E-04
	(a) Ammonia (NH3)	g	9,73E-02	9,73E-02	3,84E-06	0,00E+00	3,44E-05
	(a) Antimony (Sb)	g	1,12E-05	1,10E-05	1,34E-07	0,00E+00	2,53E-08
	(a) AOX (Adsorbable Organic Halogens)	g	1,64E-14	1,62E-14	7,8468E-17	0	9,36852E-17
	(a) Aromatic Hydrocarbons (unspecified)	g	9,12E-02	9,12E-02	4,73E-07	0,00E+00	1,06E-06
	(a) Arsenic (As)	g	3,67363E-05	3,45E-05	1,95E-06	0,00E+00	2,91E-07
	(a) Asbestos	g	4,43E-06	4,43E-06	0,00E+00	0,00E+00	0,00E+00
	(a) Barium (Ba)	g	8,61E-05	8,30E-05	1,66E-06	0,00E+00	1,36E-06

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(a) Benzaldehyde (C6H5CHO)	g	1,75E-10	1,74E-10	1,12E-12	0,00E+00	1,26E-13
(a) Benzene (C6H6)	g	8,86E-03	7,83E-03	9,88E-04	0,00E+00	3,98E-05
(a) Benzo(a)pyrene (C20H12)	g	8,45E-03	8,45E-03	6,00E-07	0,00E+00	2,32E-08
(a) Beryllium (Be)	g	1,36E-06	1,31E-06	3,18E-08	0,00E+00	2,25E-08
(a) Boron (B)	g	6,43E-04	6,10E-04	2,15E-05	0,00E+00	1,11E-05
(a) Bromium (Br)	g	1,24E-04	1,20E-04	1,96E-06	0,00E+00	2,14E-06
(a) Butane (n-C4H10)	g	2,51E-02	1,62E-02	8,35E-03	0,00E+00	5,55E-04
(a) Butene (1-CH3CH2CHCH2)	g	3,28E-04	1,15E-04	2,06E-04	0,00E+00	6,42E-06
(a) Cadmium (Cd)	g	6,56E-05	5,57E-05	9,68E-06	0,00E+00	2,07E-07
(a) Calcium (Ca)	g	0,00113877	0,00102929	9,32901E-05	0	1,61933E-05
(a) Carbon Dioxide (CO2, biomass)	g	42,9139	42,9139	0	0	0
(a) Carbon Dioxide (CO2, fossil)	g	3,17E+04	3,13E+04	3,76E+02	0,00E+00	1,63E+01
(a) Carbon Disulphide (CS2)	g	2,19415E-05	2,19412E-05	2,70153E-10	0	0
(a) Carbon Monoxide (CO)	g	2,62E+02	261,02	9,75E-01	0,00E+00	7,84E-02
(a) Carbon Tetrafluoride (CF4)	g	6,72E-01	6,72E-01	8,99E-10	0,00E+00	1,01E-10
(a) Chlorides (Cl-)	g	7,25E-02	0,0724538	0,00E+00	0,00E+00	3,23E-10
(a) Chlorinated Matter (unspecified, as Cl)	g	2,13E-01	2,13E-01	5,60E-10	0,00E+00	2,74E-10
(a) Chlorine (Cl2)	g	2,75E-02	2,75E-02	3,18E-10	0,00E+00	3,03E-10
(a) Chromium (Cr III, Cr VI)	g	1,18E-03	1,17E-03	2,50E-06	0,00E+00	4,03E-07
(a) Cobalt (Co)	g	4,99E-05	4,52E-05	4,47E-06	0,00E+00	2,10E-07
(a) Copper (Cu)	g	1,42E-04	1,35E-04	6,75E-06	0,00E+00	4,72E-07
(a) Cyanide (CN-)	g	5,60E-06	5,54E-06	2,76456E-08	0	2,98428E-08
(a) Dichloroethane (1,1-CH2ClCH2Cl)	g	1,5492E-06	1,55E-06	0,00E+00	0,00E+00	0,00E+00
(a) Dichloroethane (1,1-CHCl2CH3)	g	0,00095193	9,52E-04	0	0	0
(a) Dichloroethane (1,2-CH2ClCH2Cl)	g	8,25E-06	8,25E-06	0,00E+00	0,00E+00	0,00E+00
(a) Dioxins (unspecified)	g	2,30315E-08	2,30E-08	2,27E-13	0,00E+00	2,58E-13
(a) Ethane (C2H6)	g	9,17E-02	6,04E-02	2,67E-02	0,00E+00	4,65E-03
(a) Ethanol (C2H5OH)	g	3,57E-04	3,55E-04	9,56E-07	0,00E+00	3,72E-07
(a) Ethyl Benzene (C6H5C2H5)	g	0,000491753	0,000275789	2,06E-04	0,00E+00	9,50E-06
(a) Ethylene (C2H4)	g	0,184386	1,83E-01	0,00164287	0	0,000190814
(a) Ethylene Oxide (C2H4O)	g	2,38E-04	0,000238181	0,00E+00	0,00E+00	0,00E+00
(a) Fluorides (F-)	g	3,31E+00	3,31E+00	2,40E-08	0,00E+00	4,22E-07
(a) Fluorine (F2)	g	2,23E-05	2,23E-05	6,25E-10	0,00E+00	1,58E-09
(a) Formaldehyde (CH2O)	g	2,05E-03	2,04E-03	1,17E-05	0,00E+00	2,39E-06
(a) Halogenated Hydrocarbons (unspecified)	g	2,88E-06	2,88E-06	4,71E-12	0,00E+00	0,00E+00
(a) Halogenated Matter (unspecified)	g	5,20E-04	5,20E-04	3,94E-10	0,00E+00	1,47E-10

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(a) Halon 1301 (CF3Br)	g	3,97E-05	1,55E-05	2,34E-05	0,00E+00	7,32E-07
(a) Heptane (C7H16)	g	3,26E-03	1,13E-03	2,06E-03	0,00E+00	6,42E-05
(a) Hexane (C6H14)	g	0,00650698	0,00224982	0,00412905	0	0,000128119
(a) Hydrocarbons (except methane)	g	28,7621	27,4685	1,23772	0	0,0558389
(a) Hydrocarbons (unspecified)	g	3,14321	3,13442	7,30627E-05	0	0,00871707
(a) Hydrogen (H2)	g	0,299992	0,299991	3,85018E-07	0	1,33083E-07
(a) Hydrogen Chloride (HCl)	g	3,90E+00	3,90E+00	6,57E-04	0,00E+00	5,86E-04
(a) Hydrogen Cyanide (HCN)	g	2,19E-05	2,18912E-05	2,70E-10	0,00E+00	0,00E+00
(a) Hydrogen Fluoride (HF)	g	2,02E+00	2,02E+00	3,65E-05	0,00E+00	2,28E-05
(a) Hydrogen Sulphide (H2S)	g	1,30E-02	1,29E-02	4,85E-05	0,00E+00	2,05E-05
(a) Iodine (I)	g	3,15E-05	3,04E-05	5,35E-07	0,00E+00	5,37E-07
(a) Iron (Fe)	g	3,26E-03	3,13E-03	7,68379E-05	0	4,65324E-05
(a) Ketone (unspecified)	g	1,38E-05	1,38E-05	0,00E+00	0,00E+00	0,00E+00
(a) Lanthanum (La)	g	2,44E-06	2,36E-06	4,13E-08	0,00E+00	3,57E-08
(a) Lead (Pb)	g	1,07E-03	1,03E-03	3,22E-05	0,00E+00	2,10E-06
(a) Magnesium (Mg)	g	2,52E-03	2,44E-03	4,30E-05	0,00E+00	3,97E-05
(a) Manganese (Mn)	g	4,21E-04	4,20E-04	7,87E-07	0,00E+00	5,89E-07
(a) Mercaptans	g	2,59E-05	2,59E-05	2,70E-10	0,00E+00	2,74E-10
(a) Mercury (Hg)	g	6,43E-04	0,00064259	2,46E-07	0,00E+00	5,18E-08
(a) Metals (unspecified)	g	1,33796	1,33796	1,55946E-08	0	7,84846E-06
(a) Methane (CH4)	g	7,02E+01	6,95E+01	5,15E-01	0,00E+00	1,28E-01
(a) Methanol (CH3OH)	g	0,00060519	6,03E-04	1,62E-06	0,00E+00	6,30E-07
(a) Methylene Chloride (CH2Cl2, HC-130)	g	1,05E-05	1,05E-05	0,00E+00	0,00E+00	0,00E+00
(a) Molybdenum (Mo)	g	2,58E-05	2,34E-05	2,25E-06	0,00E+00	1,31E-07
(a) Nickel (Ni)	g	0,0030243	0,00293314	8,71594E-05	0	4,00179E-06
(a) Nitrogen (N2)	g	3,58858	3,58858	0	0	0
(a) Nitrogen Oxides (NOx as NO2)	g	82,6735	7,81E+01	4,44E+00	0,00E+00	1,82E-01
(a) Nitrous Oxide (N2O)	g	0,0790809	0,0272011	0,0482192	0	0,00366055
(a) NMVOC (Non Methanic Volatile Organic Compounds)	g	0,286383	0,286383	0	0	0
(a) Organic Matter (unspecified)	g	0,120429	0,120427	3,91747E-07	0	1,60692E-06
(a) Particulates (PM 10)	g	1,01009	1,01009	0	0	0
(a) Particulates (unspecified)	g	7,41E+01	7,38E+01	2,57E-01	0,00E+00	3,03E-02
(a) Pentane (C5H12)	g	3,37E-02	2,30E-02	1,04E-02	0,00E+00	3,32E-04
(a) Phenol (C6H5OH)	g	8,56E-07	1,33E-09	8,28E-07	0,00E+00	2,61E-08
(a) Phosphorus (P)	g	8,10E-04	8,08E-04	1,03E-06	0,00E+00	1,00E-06

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(a) Phosphorus Pentoxide (P2O5)	g	1,17397E-07	1,16E-07	5,64163E-10	0	6,73169E-10
(a) Platinum (Pt)	g	3,61E-10	3,61E-10	0,00E+00	0,00E+00	0,00E+00
(a) Polycyclic Aromatic Hydrocarbons (PAH, unspecified)	g	2,20E-03	2,20E-03	9,43E-07	0,00E+00	1,03E-07
(a) Potassium (K)	g	1,16E-03	1,13E-03	1,52E-05	0,00E+00	1,38E-05
(a) Propane (C3H8)	g	2,79E-02	1,83E-02	8,41E-03	0,00E+00	1,15E-03
(a) Propionaldehyde (CH3CH2CHO)	g	4,81E-10	4,78E-10	3,08E-12	0,00E+00	3,47E-13
(a) Propionic Acid (CH3CH2COOH)	g	6,32E-07	6,28E-07	4,06E-09	0,00E+00	4,41E-10
(a) Propylene (CH2CHCH3)	g	1,55E-03	1,10E-03	4,27E-04	0,00E+00	1,95E-05
(a) Scandium (Sc)	g	8,47E-07	8,23E-07	1,17E-08	0,00E+00	1,21E-08
(a) Selenium (Se)	g	3,49E-05	3,26E-05	1,98E-06	0,00E+00	2,86E-07
(a) Silicon (Si)	g	0,0108939	1,04E-02	3,07E-04	0,00E+00	1,74E-04
(a) Silver (Ag+)	g	8,23E-09	8,23E-09	0,00E+00	0,00E+00	0,00E+00
(a) Sodium (Na)	g	1,52E-03	1,40E-03	1,08E-04	0,00E+00	1,08E-05
(a) Strontium (Sr)	g	0,00013416	1,30E-04	2,34E-06	0,00E+00	2,22E-06
(a) Styrene (C6H5CHCH2)	g	1,02467E-07	1,02467E-07	0	0	0
(a) Sulphur Oxides (SOx as SO2)	g	2,01E+02	2,01E+02	1,70E-01	0,00E+00	3,62E-02
(a) Sulphuric Acid (H2SO4)	g	2,19E-05	2,19E-05	2,70E-10	0,00E+00	0,00E+00
(a) Tars (unspecified)	g	4,45E-05	4,45E-05	6,68E-08	0,00E+00	2,41E-09
(a) Thallium (Tl)	g	6,74E-07	6,47E-07	9,37E-09	0,00E+00	1,77E-08
(a) Thorium (Th)	g	1,46E-06	1,41E-06	2,40E-08	0,00E+00	2,28E-08
(a) Tin (Sn)	g	4,90E-07	4,72E-07	1,09E-08	0,00E+00	7,26E-09
(a) Titanium (Ti)	g	2,50E-04	2,42E-04	3,63E-06	0,00E+00	3,94E-06
(a) Toluene (C6H5CH3)	g	5,57E-03	4,20E-03	1,28E-03	0,00E+00	8,15E-05
(a) Uranium (U)	g	1,34E-06	1,29E-06	2,34E-08	0,00E+00	2,21E-08
(a) Vanadium (V)	g	0,00379252	3,43E-03	0,000347817	0	1,42389E-05
(a) Vinyl Chloride (CH2CHCl)	g	4,76E-04	4,76E-04	7,09E-12	0,00E+00	0,00E+00
(a) VOC (Volatile Organic Compounds)	g	1,12E-02	7,52E-03	0,00E+00	0,00E+00	3,66E-03
(a) Xylene (C6H4(CH3)2)	g	1,67E-03	8,07E-04	8,28E-04	0,00E+00	3,74E-05
(a) Zinc (Zn)	g	1,71E-02	2,62E-03	1,45E-02	0,00E+00	1,47E-06
(a) Zirconium (Zr)	g	2,94E-06	2,90E-06	1,44E-08	0,00E+00	1,69E-08
(ar) Aerosols and Halogenes (unspecified)	kBq	2,69427E-05	2,69E-05	3,5541E-08	0	0
(ar) Americium (Am241)	kBq	1,20E-08	1,20E-08	0,00E+00	0,00E+00	0,00E+00
(ar) Carbon (C14)	kBq	0,0120997	1,21E-02	1,18093E-05	0	0
(ar) Cerium (Ce144)	kBq	2,48E-07	2,48E-07	0,00E+00	0,00E+00	0,00E+00
(ar) Cesium (Cs134)	kBq	1,16E-06	1,16E-06	4,52E-10	0,00E+00	0,00E+00

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(ar) Cesium (Cs137)	kBq	2,02E-06	2,02E-06	4,52E-10	0,00E+00	0,00E+00
(ar) Cobalt (Co58)	kBq	3,43E-07	3,42E-07	4,52E-10	0,00E+00	0,00E+00
(ar) Cobalt (Co60)	kBq	3,4291E-07	3,42E-07	4,5234E-10	0	0
(ar) Curium (Cm alpha)	kBq	1,91E-08	1,90693E-08	0,00E+00	0,00E+00	0,00E+00
(ar) Gas (unspecified)	kBq	0,860361	8,59E-01	0,00113493	0	0
(ar) Iodine (I129)	kBq	2,29E-06	2,29E-06	0,00E+00	0,00E+00	0,00E+00
(ar) Iodine (I131)	kBq	2,04E-06	2,04E-06	2,65E-09	0,00E+00	0,00E+00
(ar) Iodine (I133)	kBq	3,92E-06	3,91516E-06	5,17E-09	0,00E+00	0,00E+00
(ar) Krypton (Kr85)	kBq	2,94E+01	2,94E+01	6,89E-05	0,00E+00	0,00E+00
(ar) Lead (Pb210)	kBq	4,34433E-05	4,29E-05	5,42623E-07	0	0
(ar) Neptunium (Np237)	kBq	3,05108E-12	3,05E-12	0	0	0
(ar) Plutonium (Pu alpha)	kBq	4,38594E-08	4,39E-08	0	0	0
(ar) Plutonium (Pu214 beta XXX)	kBq	1,06788E-06	1,07E-06	0	0	0
(ar) Plutonium (Pu238)	kBq	4,46221E-13	4,46E-13	0	0	0
(ar) Plutonium (Pu239)	kBq	1,03E-12	1,03E-12	0,00E+00	0,00E+00	0,00E+00
(ar) Polonium (Po210)	kBq	5,08E-05	4,99E-05	9,45E-07	0,00E+00	0,00E+00
(ar) Potassium (K40)	kBq	7,77797E-06	7,63E-06	1,45732E-07	0	0
(ar) Promethium (Pm147)	kBq	3,05E-07	3,05E-07	0,00E+00	0,00E+00	0,00E+00
(ar) Protactinium (Pa234m)	kBq	4,74E-06	4,7342E-06	6,39E-09	0,00E+00	0,00E+00
(ar) Radioactive Substance (unspecified)	kBq	95,4059	9,54E+01	3,42466E-09	0	0
(ar) Radium (Ra106)	kBq	3,81388E-05	3,81E-05	0	0	0
(ar) Radium (Ra222)	kBq	4,56E-08	4,56E-08	0,00E+00	0,00E+00	0,00E+00
(ar) Radium (Ra226)	kBq	3,35E-04	3,34E-04	5,79E-07	0,00E+00	0,00E+00
(ar) Radium (Ra228)	kBq	3,89E-06	3,82E-06	7,24E-08	0,00E+00	0,00E+00
(ar) Radon (Rn220)	kBq	1,19E-04	1,17E-04	1,95E-06	0,00E+00	0,00E+00
(ar) Radon (Rn222)	kBq	1,15E-03	0,00108213	7,11E-05	0,00E+00	0,00E+00
(ar) Radon (Rn226)	kBq	39,944	3,99E+01	0,0543202	0	0
(ar) Strontium (Sr90)	kBq	1,20137E-06	1,20E-06	0	0	0
(ar) Technetium (Tc99)	kBq	1,54E-10	1,54E-10	0,00E+00	0,00E+00	0,00E+00
(ar) Thorium (Th228)	kBq	3,29E-06	3,23E-06	6,11E-08	0,00E+00	0,00E+00
(ar) Thorium (Th230)	kBq	6,79E-05	6,78E-05	9,24E-08	0,00E+00	0,00E+00
(ar) Thorium (Th232)	kBq	2,09E-06	2,05E-06	3,90E-08	0,00E+00	0,00E+00
(ar) Thorium (Th234)	kBq	4,74E-06	4,7342E-06	6,39E-09	0,00E+00	0,00E+00
(ar) Tritium (H3)	kBq	0,112916	1,13E-01	0,000137773	0	0
(ar) Uranium (U alpha)	kBq	1,79E-09	1,79E-09	0,00E+00	0,00E+00	0,00E+00
(ar) Uranium (U234)	kBq	1,19E-04	1,19E-04	1,61E-07	0,00E+00	0,00E+00

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(ar) Uranium (U235)	kBq	8,91E-07	8,90E-07	1,21E-09	0,00E+00	0,00E+00
(ar) Uranium (U238)	kBq	1,41E-04	0,000140949	2,95E-07	0,00E+00	0,00E+00
(ar) Xenon (Xe133)	kBq	7,31E-01	7,30E-01	9,64E-04	0,00E+00	0,00E+00
(s) Aluminium (Al)	g	7,58E-03	7,53E-03	4,85E-05	0,00E+00	5,46E-06
(s) Arsenic (As)	g	3,02902E-06	3,01E-06	1,93768E-08	0	2,18082E-09
(s) Atrazine (C8H14ClN5)	g	6,33E-05	6,33E-05	0,00E+00	0,00E+00	0,00E+00
(s) Cadmium (Cd)	g	1,37E-09	1,36E-09	8,77E-12	0,00E+00	9,86E-13
(s) Calcium (Ca)	g	3,03E-02	3,01E-02	1,94E-04	0,00E+00	2,18E-05
(s) Carbon (C)	g	2,27E-02	2,26E-02	1,45E-04	0,00E+00	1,63E-05
(s) Chromium (Cr III, Cr VI)	g	3,79E-05	3,77E-05	2,43E-07	0,00E+00	2,73E-08
(s) Cobalt (Co)	g	1,39E-09	1,38E-09	8,89E-12	0,00E+00	9,99E-13
(s) Copper (Cu)	g	6,9574E-09	6,91E-09	4,45069E-11	0	4,99448E-12
(s) Hydrocarbons (unspecified)	g	1,45E-02	1,45E-02	0,00E+00	0,00E+00	0,00E+00
(s) Iron (Fe)	g	1,51E-02	1,50E-02	9,69E-05	0,00E+00	1,09E-05
(s) Lead (Pb)	g	3,18E-08	3,16E-08	2,03E-10	0,00E+00	2,29E-11
(s) Manganese (Mn)	g	3,03E-04	3,01E-04	1,94E-06	0,00E+00	2,18E-07
(s) Mercury (Hg)	g	2,52E-10	2,51E-10	1,61E-12	0,00E+00	1,82E-13
(s) Nickel (Ni)	g	1,04E-08	1,04E-08	6,68E-11	0,00E+00	7,51E-12
(s) Nitrogen (N)	g	3,82E-03	3,82E-03	7,59E-10	0,00E+00	8,53E-11
(s) Oils (unspecified)	g	4,50E-05	4,47E-05	2,88E-07	0,00E+00	3,23E-08
(s) Phosphorus (P)	g	3,97E-04	3,94E-04	2,43E-06	0,00E+00	2,73E-07
(s) Sulphur (S)	g	4,54E-03	4,51E-03	2,91E-05	0,00E+00	3,26E-06
(s) Zinc (Zn)	g	1,14E-04	0,000113026	7,28E-07	0,00E+00	8,19E-08
(sr) Americium (Am241)	kBq	1,05E-01	0,104664	1,19E-04	0,00E+00	0,00E+00
(sr) Americium (Am243)	kBq	1,92E-01	0,19163	2,59E-06	0,00E+00	0,00E+00
(sr) Cesium (Cs135)	kBq	4,09E+01	4,08E+01	5,81E-02	0,00E+00	0,00E+00
(sr) Cesium (Cs137)	kBq	1,12E-04	0,000111956	1,62E-07	0,00E+00	0,00E+00
(sr) Curium (Cm244)	kBq	1,89E-01	1,89E-01	2,41E-04	0,00E+00	0,00E+00
(sr) Curium (Cm245)	kBq	3,30E-05	3,29E-05	2,69E-08	0,00E+00	0,00E+00
(sr) Iodine (I129)	kBq	2,65E-06	2,64E-06	3,80E-09	0,00E+00	0,00E+00
(sr) Neptunium (Np237)	kBq	2,86E-02	2,86E-02	3,73E-05	0,00E+00	0,00E+00
(sr) Palladium (Pd107)	kBq	9,57E-04	0,000956989	1,31E-08	0,00E+00	0,00E+00
(sr) Plutonium (Pu239)	kBq	3,21E+01	32,0235	0,045117	0	0
(sr) Plutonium (Pu240)	kBq	47,5308	47,4666	0,0642042	0	0
(sr) Plutonium (Pu241)	kBq	1,18E+04	11754	1,49E+01	0,00E+00	0,00E+00
(sr) Plutonium (Pu242)	kBq	1,90E-01	0,189621	2,42E-04	0,00E+00	0,00E+00

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(sr) Radium (Ra226)	kBq	2,26E-01	2,26E-01	3,08E-04	0,00E+00	0,00E+00
(sr) Samarium (Sm151)	kBq	3,76E-02	3,75E-02	5,37E-05	0,00E+00	0,00E+00
(sr) Selenium (Se79)	kBq	3,08E-03	0,00308281	4,18E-08	0,00E+00	0,00E+00
(sr) Strontium (Sr90)	kBq	5,97E+00	5,95977	8,67E-03	0,00E+00	0,00E+00
(sr) Technetium (Tc99)	kBq	1,33E-01	0,132859	1,77E-06	0,00E+00	0,00E+00
(sr) Thorium (Th230)	kBq	2,26E-01	2,26E-01	3,08E-04	0,00E+00	0,00E+00
(sr) Tin (Sn126)	kBq	0,00531647	5,32E-03	7,31753E-08	0	0
(sr) Uranium (U233)	kBq	1,58E-05	1,58E-05	0,00E+00	0,00E+00	0,00E+00
(sr) Uranium (U234)	kBq	1,35E-01	1,35E-01	1,91E-04	0,00E+00	0,00E+00
(sr) Uranium (U235)	kBq	2,40E-03	2,40E-03	3,45E-06	0,00E+00	0,00E+00
(sr) Uranium (U238)	kBq	3,76E-02	0,0375556	5,35E-05	0,00E+00	0,00E+00
(sr) Zirconium (Zr93)	kBq	0,0270138	0,0270136	2,33E-07	0,00E+00	0,00E+00
(w) Acids (H+)	g	7,85E-01	7,82E-01	1,95E-06	0,00E+00	3,63E-03
(w) Alcohol (unspecified)	g	3,50E-05	3,48E-05	4,74E-08	0,00E+00	1,90E-07
(w) Aldehyde (unspecified)	g	3,24E-06	3,22E-06	2,07E-08	0,00E+00	2,33E-09
(w) Alkane (unspecified)	g	2,49E-03	9,74E-04	1,47E-03	0,00E+00	4,56E-05
(w) Alkene (unspecified)	g	2,30E-04	8,97746E-05	1,36E-04	0,00E+00	4,22E-06
(w) Aluminium (Al3+)	g	3,64E-01	3,63E-01	5,71E-05	0,00E+00	3,60E-04
(w) Aluminium Hydroxide (Al(OH)3)	g	4,26E-07	4,22002E-07	5,51E-10	0,00E+00	3,32E-09
(w) Ammonia (NH4+, NH3, as N)	g	1,91E-01	1,43E-01	9,65E-03	0,00E+00	3,85E-02
(w) AOX (Adsorbable Organic Halogens)	g	6,22E-05	3,73E-05	2,40E-05	0,00E+00	8,31E-07
(w) Aromatic Hydrocarbons (unspecified)	g	1,03E-02	4,28E-03	5,89E-03	0,00E+00	1,84E-04
(w) Arsenic (As3+, As5+)	g	8,99E-05	8,19E-05	4,76E-06	0,00E+00	3,20E-06
(w) Barium (Ba++)	g	4,94E-02	0,020128	2,83E-02	0,00E+00	9,71E-04
(w) Barytes	g	1,07E-01	1,07E-01	6,87E-04	0,00E+00	7,72E-05
(w) Benzene (C6H6)	g	0,00249211	0,000974233	0,00147197	0	0,000045912
(w) BOD5 (Biochemical Oxygen Demand)	g	4,99E-01	4,82E-01	5,14E-04	0,00E+00	1,68E-02
(w) Boric Acid (H3BO3)	g	5,38E-04	5,34E-04	7,04E-07	0,00E+00	3,88E-06
(w) Boron (B III)	g	6,24E-03	6,05E-03	1,84E-04	0,00E+00	5,71E-06
(w) Bromates (BrO3-)	g	3,53E-05	3,53E-05	0,00E+00	0,00E+00	0,00E+00
(w) Cadmium (Cd++)	g	2,90011E-05	1,98596E-05	7,92852E-06	0	1,21294E-06
(w) Calcium (Ca++)	g	6,45E+00	6,08E+00	3,64E-01	0,00E+00	1,13E-02
(w) Carbonates (CO3--, HCO3-, CO2, as C)	g	1,62E-02	1,62E-02	8,65E-07	0,00E+00	3,41E-06
(w) Cerium (Ce++)	g	1,84E-05	6,84E-06	1,13E-05	0,00E+00	3,06E-07
(w) Cesium (Cs++)	g	4,46E-08	2,22E-10	0,00E+00	0,00E+00	4,44E-08
(w) Chlorates (ClO3-)	g	0,0157991	0,0157991	0	0	0

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(w) Chlorides (Cl-)	g	1,78E+02	1,71E+02	5,85E+00	0,00E+00	5,21E-01
(w) Chlorinated Matter (unspecified, as Cl)	g	1,71E-02	1,70E-02	1,09E-04	0,00E+00	1,23E-05
(w) Chlorine (Cl2)	g	1,41E-04	1,41E-04	2,38E-09	0,00E+00	0,00E+00
(w) Chloroform (CHCl3, HC-20)	g	1,83E-08	1,82E-08	1,17E-10	0,00E+00	1,32E-11
(w) Chromate (CrO4--)	g	1,36E-05	1,36E-05	2,63E-10	0,00E+00	0,00E+00
(w) Chromites (CrO3-)	g	9,13E-06	9,13E-06	7,09E-12	0,00E+00	0,00E+00
(w) Chromium (Cr III)	g	7,96E-05	7,90E-05	5,09E-07	0,00E+00	6,11E-08
(w) Chromium (Cr III, Cr VI)	g	4,25E-04	3,78E-04	2,74E-05	0,00E+00	2,00E-05
(w) Chromium (Cr VI)	g	1,50E-09	1,48E-09	9,57E-12	0,00E+00	1,08E-12
(w) Cobalt (Co I, Co II, Co III)	g	4,91697E-06	4,88199E-06	3,14489E-08	0	3,53646E-09
(w) COD (Chemical Oxygen Demand)	g	2,20E+00	2,09E+00	1,70E-02	0,00E+00	9,24E-02
(w) Copper (Cu+, Cu++)	g	5,07E-04	4,89E-04	1,61E-05	0,00E+00	2,15E-06
(w) Cyanide (CN-)	g	1,90E-03	1,87E-03	2,48E-05	0,00E+00	1,60E-06
(w) Dichloroethane (1,2-CH2ClCH2Cl)	g	0,000029775	2,98E-05	0,00E+00	0,00E+00	0,00E+00
(w) Dioxins (unspecified)	g	5,18186E-07	5,18186E-07	0	0	0
(w) Dissolved Matter (unspecified)	g	6,14E+00	6,14E+00	4,08E-04	0,00E+00	7,91E-04
(w) Dissolved Organic Carbon (DOC)	g	6,87E-03	6,83E-03	3,87E-05	0,00E+00	4,62E-06
(w) Edetic Acid (EDTA, C10H16N2O8)	g	9,13E-07	9,06E-07	1,20E-09	0,00E+00	6,58E-09
(w) Ethyl Benzene (C6H5C2H5)	g	4,46E-04	1,66E-04	2,72E-04	0,00E+00	8,78E-06
(w) Fluorides (F-)	g	5,38E-02	5,36E-02	1,20E-04	0,00E+00	6,08E-06
(w) Formaldehyde (CH2O)	g	2,32E-10	2,31E-10	1,48549E-12	0	1,67206E-13
(w) Halogenated Matter (organic)	g	2,24E-14	2,24E-14	0,00E+00	0,00E+00	0,00E+00
(w) Hexachloroethane (C2Cl6)	g	3,23E-14	3,21E-14	2,07E-16	0,00E+00	2,33E-17
(w) Hydrazine (N2H4)	g	4,20E-07	4,16E-07	5,49E-10	0,00E+00	3,02E-09
(w) Hydrocarbons (unspecified)	g	7,28E-02	7,26E-02	3,53E-08	0,00E+00	1,95E-04
(w) Hypochlorite (ClO-)	g	5,51E-06	5,47E-06	3,52E-08	0,00E+00	3,97E-09
(w) Hypochlorous Acid (HClO)	g	5,51E-06	5,47E-06	3,52E-08	0,00E+00	3,97E-09
(w) Inorganic Dissolved Matter (unspecified)	g	2,58E-05	2,44E-05	9,57E-07	0,00E+00	4,31E-07
(w) Iode (I-)	g	1,85E-03	0,000685433	1,13E-03	0,00E+00	3,51E-05
(w) Iron (Fe++, Fe3+)	g	1,53E+00	1,53E+00	1,70E-03	0,00E+00	1,28E-03
(w) Lead (Pb++, Pb4+)	g	9,81E-04	9,64E-04	5,51E-06	0,00E+00	1,17E-05
(w) Lithium Salts (Lithine)	g	4,69E-08	4,65003E-08	6,14E-11	0,00E+00	3,38E-10
(w) Magnesium (Mg++)	g	6,32E-01	6,23E-01	9,43E-03	0,00E+00	3,06E-04
(w) Manganese (Mn II, Mn IV, Mn VII)	g	8,83E-02	8,77E-02	5,48E-04	0,00E+00	2,32E-05
(w) Mercury (Hg+, Hg++)	g	4,60E-05	4,59102E-05	4,72975E-08	0	8,4689E-08
(w) Metals (unspecified)	g	2,29E+01	2,29E+01	7,09E-07	0,00E+00	2,32E-04

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(w) Methane (CH4)	g	0,000145472	1,37E-04	0	0	8,87218E-06
(w) Methyl tert Butyl Ether (MTBE, C5H12O)	g	1,34E-06	1,34E-06	0,00E+00	0,00E+00	0,00E+00
(w) Methylene Chloride (CH2Cl2, HC-130)	g	6,10E-05	5,21E-05	3,36E-07	0,00E+00	8,53E-06
(w) Molybdenum (Mo II, Mo III, Mo IV, Mo V, Mo VI)	g	4,68E-05	4,17E-05	4,76E-06	0,00E+00	3,60E-07
(w) Morpholine (C4H9NO)	g	4,44E-06	4,41E-06	5,82E-09	0,00E+00	3,20E-08
(w) Nickel (Ni++, Ni3+)	g	2,85E-04	0,000255127	2,74982E-05	0	0,000002581
(w) Nitrate (NO3-)	g	6,67E-01	6,50E-01	1,70E-02	0,00E+00	5,43E-04
(w) Nitrite (NO2-)	g	1,37E-06	1,36E-06	8,74E-09	0,00E+00	9,83E-10
(w) Nitrogenous Matter (Kjeldahl, as N)	g	2,09E-04	2,08E-04	2,78E-07	0,00E+00	1,35E-06
(w) Nitrogenous Matter (unspecified, as N)	g	1,20E-02	0,00954611	0,00241596	0	8,37583E-05
(w) Oils (unspecified)	g	3,05684	3,05E+00	0,0095876	0	0,00187991
(w) Organic Dissolved Matter (aliphatic)	g	7,31063E-08	7,31E-08	0	0	0
(w) Organic Dissolved Matter (aromatic)	g	7,31E-08	7,31063E-08	0,00E+00	0,00E+00	0,00E+00
(w) Organic Dissolved Matter (chlorinated)	g	0,247634	2,48E-01	3,00949E-09	0	2,73611E-10
(w) Organic Dissolved Matter (unspecified)	g	6,13E-03	0,0061263	6,32E-08	0,00E+00	2,09E-07
(w) Organic Matter (unspecified)	g	0,138477	1,38E-01	3,21E-10	0,00E+00	0,00E+00
(w) Organo-silicon (unspecified)	g	1,35262E-17	1,35E-17	0,00E+00	0,00E+00	0,00E+00
(w) Organo-tin as Sn (unspecified)	g	2,03E-07	2,03E-07	0,00E+00	0,00E+00	0,00E+00
(w) Oxalic Acid ((COOH)2)	g	1,83E-06	1,81E-06	2,39E-09	0,00E+00	1,32E-08
(w) Phenol (C6H5OH)	g	1,88E-02	0,0174698	1,31E-03	0,00E+00	4,09E-05
(w) Phosphates (PO4 3-, HPO4--, H2PO4-, H3PO4, as P)	g	1,52E-01	1,52E-01	2,90489E-07	0	0,000468426
(w) Phosphorous Matter (unspecified, as P)	g	1,04E-03	1,04E-03	0,00E+00	0,00E+00	0,00E+00
(w) Phosphorus (P)	g	7,60E-05	2,75E-05	4,70E-05	0,00E+00	1,46E-06
(w) Phosphorus Pentoxide (P2O5)	g	3,50E-06	3,46E-06	1,68E-08	0,00E+00	2,01E-08
(w) Polycyclic Aromatic Hydrocarbons (PAH, unspecified)	g	0,0375789	3,74E-02	0,000147105	0	4,5912E-06
(w) Polycyclic Aromatic Hydrocarbons (unspecified)	g	2,91922E-07	2,91922E-07	0	0	0
(w) Potassium (K+)	g	3,79E-01	3,28E-01	5,00E-02	0,00E+00	1,55E-03
(w) Rubidium (Rb+)	g	1,85E-04	6,84916E-05	1,13E-04	0,00E+00	3,51E-06
(w) Salts (unspecified)	g	0,234196	2,32E-01	6,65E-04	0,00E+00	1,35E-03
(w) Saponifiable Oils and Fats	g	9,04E-02	3,34E-02	5,52E-02	0,00E+00	1,72E-03
(w) Selenium (Se II, Se IV, Se VI)	g	4,18E-05	3,67E-05	4,75E-06	0,00E+00	3,32E-07
(w) Silicon Dioxide (SiO2)	g	2,02E-05	2,01E-05	1,20E-07	0,00E+00	1,36E-08

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(w) Silver (Ag+)	g	1,11095E-05	4,10948E-06	6,78904E-06	0	2,10947E-07
(w) Sodium (Na+)	g	33,0645	29,4157	3,53E+00	0,00E+00	1,16E-01
(w) Strontium (Sr II)	g	0,112146	0,0419284	0,0681015	0	0,00211567
(w) Sulphate (SO4--)	g	9,27E+01	9,25E+01	9,65E-02	0,00E+00	5,99E-02
(w) Sulphide (S--)	g	3,70E-04	1,81E-04	1,84E-04	0,00E+00	5,74E-06
(w) Sulphite (SO3--)	g	1,40E-06	1,39E-06	2,34E-09	0,00E+00	7,76E-09
(w) Sulphurated Matter (unspecified, as S)	g	3,86E-09	1,64E-09	2,13449E-09	0	8,53094E-11
(w) Suspended Matter (organic)	g	4,02805E-07	4,02805E-07	0	0	0
(w) Suspended Matter (unspecified)	g	1,49E+01	1,49E+01	2,97E-03	0,00E+00	7,85E-03
(w) Tars (unspecified)	g	6,36E-07	6,35E-07	9,54E-10	0,00E+00	3,44E-11
(w) Tetrachloroethylene (C2Cl4)	g	9,25E-08	7,84E-11	5,05E-13	0,00E+00	9,24E-08
(w) Tin (Sn++, Sn4+)	g	8,21E-04	8,21E-04	1,63E-10	0,00E+00	7,26E-10
(w) Titanium (Ti3+, Ti4+)	g	0,0959834	0,0959819	1,29246E-06	0	2,56549E-07
(w) TOC (Total Organic Carbon)	g	2,41E-01	1,56E-01	8,32E-02	0,00E+00	2,65E-03
(w) Toluene (C6H5CH3)	g	2,10E-03	8,31E-04	1,22E-03	0,00E+00	4,25E-05
(w) Tributyl Phosphate ((C4H9)3PO4, TBP)	g	2,04E-06	1,92E-06	0,00E+00	0,00E+00	1,25E-07
(w) Trichloroethane (1,1,1-CH3CCl3)	g	1,78E-10	1,77E-10	1,14E-12	0,00E+00	1,28E-13
(w) Trichloroethylene (CCl2CHCl)	g	1,18E-07	4,87E-09	3,13E-11	0,00E+00	1,14E-07
(w) Triethylene Glycol (C6H14O4)	g	6,05E-03	6,00E-03	3,87E-05	0,00E+00	4,34E-06
(w) Vanadium (V3+, V5+)	g	1,41E-04	1,36E-04	4,88E-06	0,00E+00	8,72E-07
(w) Vinyl Chloride (CH2CHCl)	g	2,06E-03	2,06E-03	1,06E-11	0,00E+00	0,00E+00
(w) VOC (Volatile Organic Compounds)	g	0,00646857	0,00239277	0,00395296	0	0,000122846
(w) Water (unspecified)	litre	0,224404	0,222572	0,00117764	0	0,000654556
(w) Water: Chemically Polluted	litre	6,65781	6,36975	0,0197195	0	0,268337
(w) Water: Thermally Polluted (only)	litre	3,12E-01	3,12E-01	0,00E+00	0,00E+00	0,00E+00
(w) Xylene (C6H4(CH3)2)	g	1,75E-02	6,50E-03	1,06E-02	0,00E+00	3,32E-04
(w) Zinc (Zn++)	g	0,0161715	1,61E-02	4,79862E-05	0	7,16599E-05
(wr) Americium (Am241)	kBq	4,00E-06	4,00E-06	0,00E+00	0,00E+00	0,00E+00
(wr) Antimony (Sb124)	kBq	2,03295E-05	2,03E-05	2,68173E-08	0	0
(wr) Antimony (Sb125)	kBq	0,00272423	2,72E-03	0	0	0
(wr) Carbon (C14)	kBq	0,00200781	2,01E-03	0	0	0
(wr) Cerium (Ce144)	kBq	6,10E-05	6,10E-05	0,00E+00	0,00E+00	0,00E+00
(wr) Cesium (Cs134)	kBq	8,29E-05	8,29E-05	2,36E-08	0,00E+00	0,00E+00
(wr) Cesium (Cs137)	kBq	6,34E-04	6,34E-04	3,46E-08	0,00E+00	0,00E+00
(wr) Cobalt (Co58)	kBq	5,88E-05	5,87E-05	7,75E-08	0,00E+00	0,00E+00
(wr) Cobalt (Co60)	kBq	0,00043834	4,38E-04	4,84649E-08	0	0

Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
(wr) Curium (Cm alpha)	kBq	2,47901E-06	2,48E-06	0	0	0
(wr) Curium (Cm244)	kBq	1,90693E-06	1,91E-06	0	0	0
(wr) Iodine (I129)	kBq	3,03E-05	3,03E-05	0,00E+00	0,00E+00	0,00E+00
(wr) Iodine (I131)	kBq	2,23E-06	2,23E-06	2,94E-09	0,00E+00	0,00E+00
(wr) Manganese (Mn54)	kBq	2,93922E-06	2,94E-06	3,87719E-09	0	0
(wr) Manganese (Mn55)	kBq	5,33941E-05	5,34E-05	0	0	0
(wr) Mix (Zr95, Nb95)	kBq	3,81388E-06	3,81E-06	0	0	0
(wr) Neptunium (Np237)	kBq	8,5812E-07	8,58E-07	0	0	0
(wr) Plutonium (Pu alpha XXX)	kBq	2,09762E-05	2,10E-05	0	0	0
(wr) Plutonium (Pu238)	kBq	4,00453E-06	4,00E-06	0	0	0
(wr) Plutonium (Pu239)	kBq	2,47901E-06	2,48E-06	0	0	0
(wr) Plutonium (Pu241 beta)	kBq	6,29E-04	6,29E-04	0,00E+00	0,00E+00	0,00E+00
(wr) Protactinium (Pa234m)	kBq	8,78E-05	8,76701E-05	1,18E-07	0,00E+00	0,00E+00
(wr) Radioactive Substance (unspecified)	kBq	8,79E-01	8,79E-01	3,15E-11	0,00E+00	0,00E+00
(wr) Radium (Ra224)	kBq	9,08E-04	0,000342456	5,66E-04	0,00E+00	0,00E+00
(wr) Radium (Ra226)	kBq	1,69E-01	1,67E-01	1,36E-03	0,00E+00	0,00E+00
(wr) Radium (Ra228)	kBq	0,00181642	6,85E-04	0,00113151	0	0
(wr) Ruthenium (Ru106)	kBq	3,87E-03	3,87E-03	0,00E+00	0,00E+00	0,00E+00
(wr) Silver (Ag110m)	kBq	8,81763E-05	8,81E-05	1,16316E-07	0	0
(wr) Strontium (Sr90)	kBq	0,00645782	6,46E-03	0	0	0
(wr) Technetium (Tc99)	kBq	4,00E-05	4,00E-05	0,00E+00	0,00E+00	0,00E+00
(wr) Thorium (Th228)	kBq	3,63E-03	1,37E-03	2,26E-03	0,00E+00	0,00E+00
(wr) Thorium (Th230)	kBq	8,14E-03	8,13E-03	1,11E-05	0,00E+00	0,00E+00
(wr) Thorium (Th234)	kBq	8,78E-05	8,76701E-05	1,18E-07	0,00E+00	0,00E+00
(wr) Tritium (H3)	kBq	2,26141	2,26E+00	0,00141185	0	0
(wr) Uranium (U alpha XXX)	kBq	1,32E-06	1,32E-06	0,00E+00	0,00E+00	0,00E+00
(wr) Uranium (U234)	kBq	2,87E-03	2,87E-03	3,91E-06	0,00E+00	0,00E+00
(wr) Uranium (U235)	kBq	1,25E-04	1,25E-04	1,70E-07	0,00E+00	0,00E+00
(wr) Uranium (U238)	kBq	0,00269664	0,00269297	3,66615E-06	0	0
Hydrochloric Acid (HCl, 100%)	kg	1,29E-05	1,28642E-05	0,00E+00	0,00E+00	0,00E+00
Recovered Energy	MJ	3,92E-01	0,392471	0,00E+00	0,00E+00	0,00E+00
Recovered Energy (total)	MJ	0,37696	3,77E-01	0	0	0
Recovered Matter (total)	kg	1,94E+00	0,482422	2,20081E-06	0	1,45993
Recovered Matter (unspecified)	kg	3,82E-01	3,81E-01	2,19E-06	0,00E+00	9,46E-05
Recovered Matter: Ash	kg	5,50E-09	5,50396E-09	0	0	0
Recovered Matter: Cardboard	kg	0	0,00E+00	0	0	0

	Flow	Units	Aluminium	Aluminium stoppers production	Transport	Bottling	End of life
	Recovered Matter: Iron Scrap	kg	0,0172554	0,0172553	1,39242E-08	0	7,81744E-08
	Recovered Matter: Metals (unspecified)	kg	0	0,00E+00	0	0	0
	Recovered Matter: Non Ferrous Metals	kg	5,93E-02	5,93E-02	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Others for Energy	kg	0	0,00E+00	0	0	0
	Recovered Matter: Paraffin Wax	kg	2,09196E-07	2,09E-07	0	0	0
	Recovered Matter: Steel Scrap	kg	0,0217045	2,17E-02	0	0	5,55287E-06
	Recovered Matter: Tall Oil	kg	4,17E-04	4,17E-04	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Turpentine	kg	3,19E-05	3,19E-05	0,00E+00	0,00E+00	0,00E+00
	Silica (SiO2)	kg	0,000172005	0,000172005	0	0	0
	Waste (hazardous)	kg	0,0338312	3,37E-02	0,000113706	0	3,62953E-06
	Waste (incineration)	kg	1,98E-05	1,86E-06	0,00E+00	0,00E+00	1,79E-05
	Waste (municipal and industrial)	kg	0,690076	0,689991	1,02022E-07	0	8,40685E-05
	Waste (municipal and industrial, to incineration)	kg	1,94E-11	1,94E-11	0	0	0
	Waste (tailings)	kg	6,25E-05	6,25E-05	0,00E+00	0,00E+00	0,00E+00
	Waste (total)	kg	7,39E+00	4,28E+00	6,84E-04	0,00E+00	3,11E+00
	Waste (unspecified)	kg	2,87E-03	2,83E-03	1,59E-05	0,00E+00	2,48E-05
	Waste (unspecified, to incineration)	kg	1,18E-02	1,18E-02	6,23E-05	0,00E+00	0,00E+00
	Waste: Highly Radioactive (class C)	kg	2,45105E-06	2,44E-06	3,43E-09	0,00E+00	7,72E-09
	Waste: Intermediate Radioactive (class B)	kg	1,05E-06	9,90E-07	0	0	5,8941E-08
	Waste: Low Radioactive (class A)	kg	0,000202716	0,000130813	6,91363E-05	0	2,76713E-06
	Waste: Mineral (inert)	kg	9,06E-02	8,60E-02	3,68E-04	0,00E+00	4,31E-03
	Waste: Mining	kg	0,13198	1,31E-01	0,000178078	0	0,000654556
	Waste: Non Mineral (inert)	kg	3,10E+00	6,86E-06	8,20E-06	0,00E+00	3,10E+00
	Waste: Non Toxic Chemicals (unspecified)	kg	5,55E-03	5,54E-03	2,91638E-09	0	5,18061E-06
	Waste: Radioactive	kg	1,57E-07	1,57E-07	0,00E+00	0,00E+00	0,00E+00
	Waste: Radioactive (unspecified)	kg	1,71355E-05	5,78409E-06	1,10102E-05	0	3,41238E-07
	Waste: Slags and Ash (unspecified)	kg	0,0201242	0,0200531	3,63593E-05	0	3,47442E-05
	Waste: Treatment	kg	0,00065383	0,000613813	0	0	4,00179E-05
Reminders:	E Feedstock Energy	MJ	73,319	73,2846	-0,000612022	0	0,0350544
	E Fuel Energy	MJ	450,03	444,726	5,0229	0	0,281056
	E Non Renewable Energy	MJ	441,921	436,592	5,01907	0	0,310216
	E Renewable Energy	MJ	81,4287	81,4207	0,00321869	0	0,00480835
	E Total Primary Energy	MJ	523,352	518,013	5,02228	0	0,31642
	Electricity	MJ elec	169,037	168,996	0,0137988	0	0,0270508

Table 23: Inventory of the aluminium closures LCA

	Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
Inputs:	(r) Barium Sulphate (BaSO4, in ground)	kg	0,000337464	2,24987E-06	3,26404E-06	0,0002191	0,00011285
	(r) Bauxite (Al2O3, ore)	kg	2,87E-03	1,31E-04	2,84E-06	7,19E-06	2,73E-03
	(r) Bentonite (Al2O3.4SiO2.H2O, in ground)	kg	5,34E-04	0,000330129	3,08E-07	2,72E-05	1,76E-04
	(r) Calcium Sulphate (CaSO4, ore)	kg	1,37E-04	3,32E-05	5,21E-07	2,72E-06	1,01E-04
	(r) Carbon Dioxide (CO2, in ground)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	(r) Chromium (Cr, ore)	kg	2,18E-05	2,06E-05	6,28E-10	1,12E-06	2,10E-08
	(r) Clay (in ground)	kg	3,01E+00	3,49E-04	3,91E-06	9,64E-06	3,01E+00
	(r) Coal (in ground)	kg	1,3895	1,06872	0,000199984	0,354519	-0,0339356
	(r) Copper (Cu, ore)	kg	1,03E-04	3,52E-07	3,19E-09	1,03E-04	1,07E-07
	(r) Dolomite (CaCO3.MgCO3, in ground)	kg	1,52E-04	1,40E-04	1,99E-13	1,16E-05	0,00E+00
	(r) Feldspar (ore)	kg	5,89E-16	5,37E-16	0,00E+00	5,24E-17	0,00E+00
	(r) Ferromanganese (Fe, Mn, C; Ore)	kg	1,13E-05	1,04E-05	2,73E-16	8,60E-07	0,00E+00
	(r) Fluorspar (CaF2, ore)	kg	6,84E-06	4,61E-06	0,00E+00	2,23E-06	0,00E+00
	(r) Granite (in ground)	kg	5,69E-13	3,48E-13	0,00E+00	2,21E-13	0,00E+00
	(r) Gravel (unspecified)	kg	2,83E-04	6,39E-05	7,12E-05	3,49E-06	1,45E-04
	(r) Iron (Fe, ore)	kg	1,60E-02	1,15E-02	1,01E-05	9,47E-04	3,58E-03
	(r) Iron Sulphate (FeSO4, ore)	kg	1,14E-06	5,96E-09	6,09E-09	0,00E+00	1,12E-06
	(r) Lead (Pb, ore)	kg	1,62E-05	1,30E-05	9,97E-10	3,13E-06	3,36E-08
	(r) Lignite (in ground)	kg	6,08E-03	3,02E-04	5,19E-06	6,26E-04	5,15E-03
	(r) Limestone (CaCO3, in ground)	kg	0,0362073	0,00356012	2,54484E-05	0,027075	0,00554674
	(r) Magnesium (Mg, ore)	kg	1,41E-08	1,41E-08	0,00E+00	1,52E-22	0,00E+00
	(r) Manganese (Mn, ore)	kg	1,27E-08	1,09E-10	3,66E-10	0,00E+00	1,23E-08
	(r) Mercury (Hg, ore)	kg	2,94E-06	9,48E-09	0,00E+00	2,93E-06	0,00E+00
	(r) Natural Gas (in ground)	kg	3,74656	3,87E+00	2,44E-03	5,44E-01	-6,69E-01
	(r) Nickel (Ni, ore)	kg	8,03E-08	2,83E-08	2,12E-10	4,47E-08	7,12E-09
	(r) Oil (in ground)	kg	5,53E+00	5,67E+00	9,72E-02	5,34E-01	-7,65E-01
	(r) Olivine ((Mg,Fe)2SiO4, ore)	kg	1,17E-04	1,08E-04	2,25427E-14	8,87992E-06	0
	(r) Peat (in ground)	kg	1,36E-02	1,33E-02	0,00E+00	2,96E-04	0,00E+00
	(r) Perlite (SiO2, ore)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	(r) Phosphate Rock (in ground)	kg	0,00281477	5,10E-10	0	1,0314E-06	0,00281373
	(r) Potassium Chloride (KCl, as K2O, in ground)	kg	6,99E-04	5,65E-07	4,87E-09	6,99E-04	0,00E+00
	(r) Pyrite (FeS2, ore)	kg	1,82E-04	1,57E-06	5,23E-06	0,00E+00	1,76E-04
	(r) Quartzite (SiO2, in ground)	kg	1,05E-21	4,19E-25	0,00E+00	1,05E-21	0,00E+00
	(r) Rutile (TiO2, ore)	kg	3,19679E-06	3,20E-06	0,00E+00	2,09E-11	0,00E+00

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(r) Sand (in ground)	kg	0,451682	6,75E-04	1,26E-06	5,91E-04	4,50E-01
(r) Silver (Ag, ore)	kg	5,51E-10	4,74E-12	1,58E-11	0,00E+00	5,31E-10
(r) Sodium Chloride (NaCl, in ground or in sea)	kg	1,08E+00	4,43E-03	1,33E-05	1,08E+00	-2,80E-03
(r) Sodium Nitrate (NaNO3)	kg	4,22339E-08	4,22E-08	0,00E+00	4,56E-22	0,00E+00
(r) Sulphur (in natural gas)	kg	0,000279765	0,00E+00	0,00E+00	0,00E+00	2,80E-04
(r) Sulphur (S, in ground)	kg	3,28E-04	7,68E-04	3,40E-10	-4,41E-04	1,36E-06
(r) Talcum (4SiO2.3MgO.H2O, ore)	kg	1,12E-25	8,67E-26	0,00E+00	2,57E-26	0,00E+00
(r) Tin (Sn, ore)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(r) Titanium (Ti, ore)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(r) Uranium (U, ore)	kg	3,27E-04	2,57E-04	4,93E-08	6,45E-05	5,48E-06
(r) Wood (standing)	kg	1,96E-06	9,69E-07	9,95E-07	0,00E+00	0,00E+00
(r) Wood (standing, in kg)	kg	1,18E+00	1,12E+00	0,00E+00	5,50E-02	0,00E+00
(r) Wood (standing, kg)	kg	2,18E-06	2,18E-06	0,00E+00	0,00E+00	0,00E+00
(r) Zinc (Zn, ore)	kg	1,48E-03	1,48E-03	2,32E-11	7,71E-07	1,41E-06
(w) Phosphorous Matter (unspecified, as P)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
_(a) Carbon dioxyde (from air, sink effect)	g	0,00E+00	0	0	0	0
_(r) Cork Standing	kg	0	0	0	0	0
_Biofuel	MJ	0	0,00E+00	0	0	0
Adjuvant (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
Alloy (unspecified)	kg	0	0	0	0	0
Amine (unspecified)	kg	0	0	0	0	0
Antifoaming Agent (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
Biocide (unspecified)	kg	0	0,00E+00	0	0	0
Biomass (unspecified)	kg	0,180607	1,63E-01	0	0,0173763	0
Catalyst (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
Detergent Agent (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
Dewaxing Agent (unspecified)	kg	0	0,00E+00	0	0	0
Explosive (unspecified)	kg	1,75E-05	6,87E-08	8,38893E-08	0	1,73032E-05
Ferromanganese (Fe, Mn, C)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Furfural (C5H4O2)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Iron Scrap	kg	1,90E-02	2,37E-05	8,04399E-05	0	0,0189225
Land Use (II -> III)	m2a	1,77E-06	8,26883E-07	9,43E-07	0,00E+00	0,00E+00
Land Use (II -> IV)	m2a	4,41E-07	1,57E-07	2,83E-07	0,00E+00	0,00E+00
Land Use (III -> IV)	m2a	7,54E-08	3,73E-08	3,81E-08	0,00E+00	0,00E+00
Maize	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Peat	kg	0	0,00E+00	0	0	0

	Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
	Potatoes	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Raw Materials (unspecified)	kg	0,00105554	2,56E-05	7,31723E-05	1,77009E-09	0,000956719
	Recovered Matter (total)	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Aluminium Scrap	kg	0	0,00E+00	0	0	0
	Recovered Matter: Iron Scrap	kg	0	0	0	0	0
	Recovered Matter: Others for Energy	kg	0	0,00E+00	0	0	0
	Recovered Matter: Paper, Cardboard	kg	0	0,00E+00	0	0	0
	Sodium Hydrocarbonate (NaHCO3)	kg	0	0,00E+00	0	0	0
	Solvent (unspecified)	kg	0,00E+00	0,00E+00	0	0	0
	Steel	kg	0	0,00E+00	0	0	0
	Trinitrotoluene (C6H2CH3(NO2)3)	kg	0	0,00E+00	0	0	0
	Urea (H2NCONH2)	kg	0	0	0	0	0
	Water Used (total)	litre	41,3052	2,92E+01	0,403094	10,9261	0,82176
	Water: Ground	litre	0	0	0	0	0
	Water: Public Network	litre	26,2617	17,8305	4,55524E-07	3,44529	4,98589
	Water: River	litre	6,68001	5,79098	1,9645E-11	0,889026	0
	Water: Sea	litre	1,2573	1,05448	2,11007E-09	0,202818	0
	Water: Unspecified Origin	litre	6,29025	4,33E+00	0,403094	5,72306	-4,16418
	Water: Well	litre	8,16E-01	1,50E-01	1,04E-11	6,66E-01	0,00E+00
	Wood	kg	0,000264132	3,18E-08	1,07589E-07	0	0,000263992
	Wood (standing, maritime pine)	m3	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Outputs:	(a) Acetaldehyde (CH3CHO)	g	9,67E-06	2,02E-07	1,71E-07	0,00E+00	9,30E-06
	(a) Acetic Acid (CH3COOH)	g	4,47E-04	4,32E-06	1,24E-05	0,00E+00	4,30E-04
	(a) Acetone (CH3COCH3)	g	7,21E-06	1,81E-07	1,01E-07	0,00E+00	6,93E-06
	(a) Acetylene (C2H2)	g	3,25E-04	1,66E-06	1,69E-06	0,00E+00	3,21E-04
	(a) Aldehyde (unspecified)	g	1,43E-04	7,44E-05	3,02E-07	4,47E-07	6,83E-05
	(a) Alkane (unspecified)	g	1,11E-02	5,89E-04	1,98E-03	0,00E+00	8,54E-03
	(a) Alkene (unspecified)	g	3,44E-04	1,84E-06	2,21E-06	0,00E+00	3,40E-04
	(a) Alkyne (unspecified)	g	2,00E-07	1,59E-09	5,33E-09	0,00E+00	1,93E-07
	(a) Aluminium (Al)	g	6,09E-03	3,19E-05	3,27E-05	0,00E+00	6,02E-03
	(a) Ammonia (NH3)	g	1,32E-02	1,12E-05	2,53E-06	1,28E-02	3,61E-04
	(a) Antimony (Sb)	g	3,22E-06	1,93E-06	6,27E-09	2,42E-09	1,29E-06
	(a) AOX (Adsorbable Organic Halogens)	g	5,29E-15	2,65E-17	2,71086E-17	0	5,23232E-15
	(a) Aromatic Hydrocarbons (unspecified)	g	3,64E-01	3,43E-01	8,66E-08	2,12E-02	1,40E-04
	(a) Arsenic (As)	g	1,97347E-05	1,32E-06	1,50E-06	4,26E-06	1,26E-05
	(a) Asbestos	g	5,09E-08	5,84E-11	0,00E+00	5,08E-08	0,00E+00

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(a) Barium (Ba)	g	7,34E-05	3,82E-07	3,93E-07	0,00E+00	7,26E-05
(a) Benzaldehyde (C6H5CHO)	g	3,35E-11	2,88E-13	9,61E-13	0,00E+00	3,22E-11
(a) Benzene (C6H6)	g	2,70E-03	2,46E-04	8,25E-04	2,32E-09	1,63E-03
(a) Benzo(a)pyrene (C20H12)	g	1,65E-06	1,43E-07	4,71E-07	0,00E+00	1,04E-06
(a) Beryllium (Be)	g	1,21E-06	6,25E-09	6,40E-09	0,00E+00	1,19E-06
(a) Boron (B)	g	5,93E-04	3,05E-06	3,19E-06	0,00E+00	5,87E-04
(a) Bromium (Br)	g	1,16E-04	6,07E-07	6,28E-07	0,00E+00	1,14E-04
(a) Butane (n-C4H10)	g	1,29E-02	2,09E-03	7,05E-03	0,00E+00	3,72E-03
(a) Butene (1-CH3CH2CHCH2)	g	2,50E-04	5,16E-05	1,74E-04	0,00E+00	2,39E-05
(a) Cadmium (Cd)	g	1,71E-05	4,17E-06	8,10E-06	1,31E-06	3,50E-06
(a) Calcium (Ca)	g	0,000840645	7,77351E-06	1,69953E-05	0	0,000815876
(a) Carbon Dioxide (CO2, biomass)	g	1089,35	1028,35	0	50,4047	10,6003
(a) Carbon Dioxide (CO2, fossil)	g	1,17E+04	1,02E+04	3,17E+02	2,66E+03	-1,53E+03
(a) Carbon Disulphide (CS2)	g	2,74711E-06	1,32782E-07	9,30401E-11	2,61424E-06	0
(a) Carbon Monoxide (CO)	g	3,95E+01	35,2557	8,18E-01	3,41E+00	9,97E-03
(a) Carbon Tetrafluoride (CF4)	g	4,16E-06	2,31E-10	7,73E-10	0,00E+00	4,16E-06
(a) Chlorides (Cl-)	g	4,69E-08	0	0,00E+00	0,00E+00	4,69E-08
(a) Chlorinated Matter (unspecified, as Cl)	g	1,10E-02	1,58E-05	1,93E-10	1,09E-02	5,55E-07
(a) Chlorine (Cl2)	g	1,32E-01	8,58E-05	1,18E-10	1,32E-01	5,67E-07
(a) Chromium (Cr III, Cr VI)	g	1,68E-04	4,54E-06	1,89E-06	1,42E-04	1,91E-05
(a) Cobalt (Co)	g	8,64E-06	1,11E-06	3,61E-06	0,00E+00	3,92E-06
(a) Copper (Cu)	g	6,16E-05	1,93E-06	5,46E-06	3,27E-05	2,15E-05
(a) Cyanide (CN-)	g	1,68E-06	9,11E-09	1,10728E-08	0	1,65857E-06
(a) Dichloroethane (1,1-CH2ClCH2Cl)	g	0	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(a) Dichloroethane (1,1-CHCl2CH3)	g	0,0512739	2,12E-05	0	0,0512527	0
(a) Dichloroethane (1,2-CH2ClCH2Cl)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(a) Dioxins (unspecified)	g	3,10637E-07	1,24E-10	9,96E-14	3,10E-07	1,29E-11
(a) Ethane (C2H6)	g	4,90E-02	6,67E-03	2,25E-02	0,00E+00	1,98E-02
(a) Ethanol (C2H5OH)	g	1,37E-05	3,56E-07	1,82E-07	0,00E+00	1,32E-05
(a) Ethyl Benzene (C6H5C2H5)	g	0,000254967	5,16488E-05	1,74E-04	2,54E-10	2,89E-05
(a) Ethylene (C2H4)	g	0,0601472	7,93E-03	0,00134214	0,0153726	0,0355041
(a) Ethylene Oxide (C2H4O)	g	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
(a) Fluorides (F-)	g	9,64E-06	5,87E-09	2,08E-08	0,00E+00	9,61E-06
(a) Fluorine (F2)	g	6,98E-06	1,82E-06	7,75E-10	4,37E-06	7,82E-07
(a) Formaldehyde (CH2O)	g	3,47E-04	3,19E-06	8,59E-06	0,00E+00	3,35E-04
(a) Halogenated Hydrocarbons (unspecified)	g	1,01E-09	1,59E-12	1,62E-12	0,00E+00	1,01E-09

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(a) Halogenated Matter (unspecified)	g	4,38E-02	2,80E-02	1,36E-10	1,57E-02	5,63E-07
(a) Halon 1301 (CF3Br)	g	2,85E-05	5,86E-06	1,98E-05	0,00E+00	2,86E-06
(a) Heptane (C7H16)	g	2,50E-03	5,16E-04	1,74E-03	0,00E+00	2,35E-04
(a) Hexane (C6H14)	g	0,00499057	0,00103197	0,00348891	0	0,000469686
(a) Hydrocarbons (except methane)	g	1,62073	0,309289	1,0461	0	0,265344
(a) Hydrocarbons (unspecified)	g	8,22744	26,5099	6,31372E-05	2,19666	-20,4791
(a) Hydrogen (H2)	g	5,18519	0,54422	1,32599E-07	4,6405	0,000467532
(a) Hydrogen Chloride (HCl)	g	7,87E-01	5,72E-01	3,20E-04	2,30E-01	-1,49E-02
(a) Hydrogen Cyanide (HCN)	g	1,84E-10	9,14037E-11	9,30E-11	4,17E-16	0,00E+00
(a) Hydrogen Fluoride (HF)	g	2,77E-02	2,09E-02	2,21E-05	6,34E-03	3,85E-04
(a) Hydrogen Sulphide (H2S)	g	9,95E-03	7,01E-03	3,52E-05	8,77E-04	2,03E-03
(a) Iodine (I)	g	2,90E-05	1,52E-07	1,59E-07	0,00E+00	2,87E-05
(a) Iron (Fe)	g	2,51E-03	1,85E-05	0,000031717	0	0,00245495
(a) Ketone (unspecified)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(a) Lanthanum (La)	g	4,08E-07	1,00E-08	1,02E-08	0,00E+00	3,87E-07
(a) Lead (Pb)	g	4,24E-04	5,16E-05	2,66E-05	1,27E-04	2,19E-04
(a) Magnesium (Mg)	g	2,14E-03	1,12E-05	1,15E-05	0,00E+00	2,12E-03
(a) Manganese (Mn)	g	8,94E-05	2,01E-07	5,17E-07	0,00E+00	8,87E-05
(a) Mercaptans	g	2,22E-03	1,97E-03	9,31E-11	2,50E-04	5,55E-07
(a) Mercury (Hg)	g	3,62E-04	2,11991E-05	1,92E-07	3,37E-04	3,86E-06
(a) Metals (unspecified)	g	0,0162089	0,0134615	1,26415E-08	0,00307619	-0,000328818
(a) Methane (CH4)	g	1,35E+02	1,07E+02	4,33E-01	2,64E+01	1,07E+00
(a) Methanol (CH3OH)	g	2,31704E-05	6,03E-07	3,04E-07	0,00E+00	2,23E-05
(a) Methylene Chloride (CH2Cl2, HC-130)	g	3,31E-04	2,15E-07	0,00E+00	3,31E-04	0,00E+00
(a) Molybdenum (Mo)	g	5,70E-06	5,61E-07	1,81E-06	0,00E+00	3,33E-06
(a) Nickel (Ni)	g	0,000352545	2,23659E-05	7,20907E-05	0,000194955	6,31332E-05
(a) Nitrogen (N2)	g	0	0	0	0	0
(a) Nitrogen Oxides (NOx as NO2)	g	30,0841	2,86E+01	3,75E+00	6,62E+00	-8,84E+00
(a) Nitrous Oxide (N2O)	g	0,0685654	0,0120478	0,0407644	5,00626E-09	0,0157532
(a) NMVOC (Non Methanic Volatile Organic Compounds)	g	2,31926	2,27705	0	0,0422091	0
(a) Organic Matter (unspecified)	g	0,880233	0,812298	5,75194E-07	0,0726586	-0,0047242
(a) Particulates (PM 10)	g	6,9721	5,39756	0	1,57453	0
(a) Particulates (unspecified)	g	-1,37E+00	6,42E-02	2,17E-01	0,00E+00	-1,65E+00
(a) Pentane (C5H12)	g	1,58E-02	2,61E-03	8,82E-03	0,00E+00	4,41E-03
(a) Phenol (C6H5OH)	g	9,22E-07	2,21E-12	7,38E-12	0,00E+00	9,22E-07

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(a) Phosphorus (P)	g	5,39E-05	2,82E-07	2,91E-07	0,00E+00	5,33E-05
(a) Phosphorus Pentoxide (P2O5)	g	3,63452E-08	1,91E-10	1,94904E-10	0	3,59595E-08
(a) Platinum (Pt)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(a) Polycyclic Aromatic Hydrocarbons (PAH, unspecified)	g	2,94E-05	4,94E-07	8,09E-07	3,96E-09	2,81E-05
(a) Potassium (K)	g	7,87E-04	4,32E-06	5,57E-06	0,00E+00	7,77E-04
(a) Propane (C3H8)	g	1,50E-02	2,10E-03	7,09E-03	0,00E+00	5,82E-03
(a) Propionaldehyde (CH3CH2CHO)	g	9,21E-11	7,92E-13	2,65E-12	0,00E+00	8,87E-11
(a) Propionic Acid (CH3CH2COOH)	g	1,21E-07	1,04E-09	3,49E-09	0,00E+00	1,17E-07
(a) Propylene (CH2CHCH3)	g	7,27E-03	5,67E-03	3,51E-04	8,52E-04	3,97E-04
(a) Scandium (Sc)	g	6,50E-07	3,40E-09	3,48E-09	0,00E+00	6,43E-07
(a) Selenium (Se)	g	1,51E-05	5,07E-07	1,53E-06	1,17E-08	1,31E-05
(a) Silicon (Si)	g	0,00928971	4,79E-05	4,93E-05	0,00E+00	9,19E-03
(a) Silver (Ag+)	g	5,61E-07	2,25E-10	0,00E+00	5,61E-07	0,00E+00
(a) Sodium (Na)	g	5,20E-04	2,72E-05	8,47E-05	0,00E+00	4,08E-04
(a) Strontium (Sr)	g	0,000119221	6,23E-07	6,37E-07	0,00E+00	1,18E-04
(a) Styrene (C6H5CHCH2)	g	2,45425E-09	2,44105E-09	0	1,31939E-11	0
(a) Sulphur Oxides (SOx as SO2)	g	4,48E+01	4,03E+01	1,39E-01	9,55E+00	-5,23E+00
(a) Sulphuric Acid (H2SO4)	g	2,41E-10	1,10E-10	9,31E-11	3,76E-11	0,00E+00
(a) Tars (unspecified)	g	1,13E-07	1,67E-08	5,62E-08	0,00E+00	4,05E-08
(a) Thallium (Tl)	g	7,32E-07	3,11E-09	3,18E-09	0,00E+00	7,25E-07
(a) Thorium (Th)	g	1,23E-06	6,42E-09	6,56E-09	0,00E+00	1,22E-06
(a) Tin (Sn)	g	3,88E-07	2,01E-09	2,05E-09	0,00E+00	3,84E-07
(a) Titanium (Ti)	g	2,13E-04	1,12E-06	1,14E-06	0,00E+00	2,11E-04
(a) Toluene (C6H5CH3)	g	2,24E-03	3,21E-04	1,08E-03	4,54E-10	8,33E-04
(a) Uranium (U)	g	1,19E-06	6,23E-09	6,36E-09	0,00E+00	1,18E-06
(a) Vanadium (V)	g	0,000554374	8,79E-05	0,000287975	0	0,000178468
(a) Vinyl Chloride (CH2CHCl)	g	8,37E-02	4,58E-05	2,44E-12	8,36E-02	0,00E+00
(a) VOC (Volatile Organic Compounds)	g	5,92E-03	0,00E+00	0,00E+00	0,00E+00	5,92E-03
(a) Xylene (C6H4(CH3)2)	g	1,08E-03	2,07E-04	6,98E-04	2,17E-10	1,72E-04
(a) Zinc (Zn)	g	1,66E-02	3,73E-03	1,22E-02	1,32E-05	6,85E-04
(a) Zirconium (Zr)	g	9,09E-07	4,77E-09	4,87E-09	0,00E+00	8,99E-07
(ar) Aerosols and Halogenes (unspecified)	kBq	6,82609E-08	0,00E+00	6,82609E-08	0	0
(ar) Americium (Am241)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Carbon (C14)	kBq	2,26812E-05	0,00E+00	2,26812E-05	0	0
(ar) Cerium (Ce144)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(ar) Cesium (Cs134)	kBq	8,69E-10	0,00E+00	8,69E-10	0,00E+00	0,00E+00
(ar) Cesium (Cs137)	kBq	8,69E-10	0,00E+00	8,69E-10	0,00E+00	0,00E+00
(ar) Cobalt (Co58)	kBq	8,69E-10	0,00E+00	8,69E-10	0,00E+00	0,00E+00
(ar) Cobalt (Co60)	kBq	8,68774E-10	0,00E+00	8,68774E-10	0	0
(ar) Curium (Cm alpha)	kBq	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
(ar) Gas (unspecified)	kBq	0,00217977	0,00E+00	0,00217977	0	0
(ar) Iodine (I129)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Iodine (I131)	kBq	5,09E-09	0,00E+00	5,09E-09	0,00E+00	0,00E+00
(ar) Iodine (I133)	kBq	9,93E-09	0	9,93E-09	0,00E+00	0,00E+00
(ar) Krypton (Kr85)	kBq	1,32E-04	0,00E+00	1,32E-04	0,00E+00	0,00E+00
(ar) Lead (Pb210)	kBq	3,26532E-07	1,42E-07	1,84821E-07	0	0
(ar) Neptunium (Np237)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu alpha)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu214 beta XXX)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu238)	kBq	0	0,00E+00	0	0	0
(ar) Plutonium (Pu239)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Polonium (Po210)	kBq	5,18E-07	2,56E-07	2,62E-07	0,00E+00	0,00E+00
(ar) Potassium (K40)	kBq	7,92441E-08	3,92E-08	4,00474E-08	0	0
(ar) Promethium (Pm147)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Protactinium (Pa234m)	kBq	1,23E-08	0	1,23E-08	0,00E+00	0,00E+00
(ar) Radioactive Substance (unspecified)	kBq	2,34113E-09	1,16E-09	1,18313E-09	0	0
(ar) Radium (Ra106)	kBq	0	0,00E+00	0	0	0
(ar) Radium (Ra222)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Radium (Ra226)	kBq	9,30E-07	3,62E-08	8,93E-07	0,00E+00	0,00E+00
(ar) Radium (Ra228)	kBq	3,96E-08	1,96E-08	2,00E-08	0,00E+00	0,00E+00
(ar) Radon (Rn220)	kBq	1,22E-06	6,03E-07	6,16E-07	0,00E+00	0,00E+00
(ar) Radon (Rn222)	kBq	7,42E-05	1,82449E-05	5,59E-05	0,00E+00	0,00E+00
(ar) Radon (Rn226)	kBq	0,104329	0,00E+00	0,104329	0	0
(ar) Strontium (Sr90)	kBq	0	0,00E+00	0	0	0
(ar) Technetium (Tc99)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(ar) Thorium (Th228)	kBq	3,35E-08	1,66E-08	1,69E-08	0,00E+00	0,00E+00
(ar) Thorium (Th230)	kBq	1,77E-07	0,00E+00	1,77E-07	0,00E+00	0,00E+00
(ar) Thorium (Th232)	kBq	2,13E-08	1,06E-08	1,08E-08	0,00E+00	0,00E+00
(ar) Thorium (Th234)	kBq	1,23E-08	0	1,23E-08	0,00E+00	0,00E+00
(ar) Tritium (H3)	kBq	0,00026461	0,00E+00	0,00026461	0	0
(ar) Uranium (U alpha)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(ar) Uranium (U234)	kBq	3,10E-07	0,00E+00	3,10E-07	0,00E+00	0,00E+00
(ar) Uranium (U235)	kBq	2,32E-09	0,00E+00	2,32E-09	0,00E+00	0,00E+00
(ar) Uranium (U238)	kBq	4,14E-07	3,01514E-08	3,84E-07	0,00E+00	0,00E+00
(ar) Xenon (Xe133)	kBq	1,85E-03	0,00E+00	1,85E-03	0,00E+00	0,00E+00
(s) Aluminium (Al)	g	1,45E-03	1,25E-05	4,17E-05	0,00E+00	1,40E-03
(s) Arsenic (As)	g	5,79704E-07	4,98E-09	1,66462E-08	0	5,58074E-07
(s) Atrazine (C8H14ClN5)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(s) Cadmium (Cd)	g	2,63E-10	2,25E-12	7,53E-12	0,00E+00	2,53E-10
(s) Calcium (Ca)	g	5,80E-03	4,98E-05	1,66E-04	0,00E+00	5,58E-03
(s) Carbon (C)	g	4,35E-03	3,74E-05	1,25E-04	0,00E+00	4,19E-03
(s) Chromium (Cr III, Cr VI)	g	7,26E-06	6,24E-08	2,08E-07	0,00E+00	6,99E-06
(s) Cobalt (Co)	g	2,67E-10	2,29E-12	7,64E-12	0,00E+00	2,57E-10
(s) Copper (Cu)	g	1,33415E-09	1,14E-11	3,8235E-11	0	1,28447E-09
(s) Hydrocarbons (unspecified)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(s) Iron (Fe)	g	2,90E-03	2,49E-05	8,32E-05	0,00E+00	2,79E-03
(s) Lead (Pb)	g	6,10E-09	5,23E-11	1,75E-10	0,00E+00	5,87E-09
(s) Manganese (Mn)	g	5,80E-05	4,98E-07	1,66E-06	0,00E+00	5,58E-05
(s) Mercury (Hg)	g	4,84E-11	4,15E-13	1,39E-12	0,00E+00	4,66E-11
(s) Nickel (Ni)	g	2,00E-09	1,72E-11	5,74E-11	0,00E+00	1,93E-09
(s) Nitrogen (N)	g	2,27E-08	1,95E-10	6,52E-10	0,00E+00	2,19E-08
(s) Oils (unspecified)	g	8,63E-06	7,40E-08	2,47E-07	0,00E+00	8,30E-06
(s) Phosphorus (P)	g	7,26E-05	6,24E-07	2,08E-06	0,00E+00	6,99E-05
(s) Sulphur (S)	g	8,70E-04	7,47E-06	2,50E-05	0,00E+00	8,37E-04
(s) Zinc (Zn)	g	2,18E-05	1,87268E-07	6,26E-07	0,00E+00	2,10E-05
(sr) Americium (Am241)	kBq	2,29E-04	0	2,29E-04	0,00E+00	0,00E+00
(sr) Americium (Am243)	kBq	4,98E-06	0	4,98E-06	0,00E+00	0,00E+00
(sr) Cesium (Cs135)	kBq	1,12E-01	0,00E+00	1,12E-01	0,00E+00	0,00E+00
(sr) Cesium (Cs137)	kBq	3,12E-07	0	3,12E-07	0,00E+00	0,00E+00
(sr) Curium (Cm244)	kBq	4,64E-04	0,00E+00	4,64E-04	0,00E+00	0,00E+00
(sr) Curium (Cm245)	kBq	5,17E-08	0,00E+00	5,17E-08	0,00E+00	0,00E+00
(sr) Iodine (I129)	kBq	7,30E-09	0,00E+00	7,30E-09	0,00E+00	0,00E+00
(sr) Neptunium (Np237)	kBq	7,16E-05	0,00E+00	7,16E-05	0,00E+00	0,00E+00
(sr) Palladium (Pd107)	kBq	2,51E-08	0	2,51E-08	0,00E+00	0,00E+00
(sr) Plutonium (Pu239)	kBq	8,67E-02	0	0,0866529	0	0
(sr) Plutonium (Pu240)	kBq	0,123312	0	0,123312	0	0
(sr) Plutonium (Pu241)	kBq	2,86E+01	0	2,86E+01	0,00E+00	0,00E+00

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(sr) Plutonium (Pu242)	kBq	4,66E-04	0	4,66E-04	0,00E+00	0,00E+00
(sr) Radium (Ra226)	kBq	5,91E-04	0,00E+00	5,91E-04	0,00E+00	0,00E+00
(sr) Samarium (Sm151)	kBq	1,03E-04	0,00E+00	1,03E-04	0,00E+00	0,00E+00
(sr) Selenium (Se79)	kBq	8,03E-08	0	8,03E-08	0,00E+00	0,00E+00
(sr) Strontium (Sr90)	kBq	1,67E-02	0	1,67E-02	0,00E+00	0,00E+00
(sr) Technetium (Tc99)	kBq	3,40E-06	0	3,40E-06	0,00E+00	0,00E+00
(sr) Thorium (Th230)	kBq	5,91E-04	0,00E+00	5,91E-04	0,00E+00	0,00E+00
(sr) Tin (Sn126)	kBq	1,40543E-07	0,00E+00	1,40543E-07	0	0
(sr) Uranium (U233)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(sr) Uranium (U234)	kBq	3,67E-04	0,00E+00	3,67E-04	0,00E+00	0,00E+00
(sr) Uranium (U235)	kBq	6,63E-06	0,00E+00	6,63E-06	0,00E+00	0,00E+00
(sr) Uranium (U238)	kBq	1,03E-04	0	1,03E-04	0,00E+00	0,00E+00
(sr) Zirconium (Zr93)	kBq	4,47361E-07	0	4,47E-07	0,00E+00	0,00E+00
(w) Acids (H+)	g	-1,92E-02	2,70E-02	1,67E-06	1,50E-02	-6,12E-02
(w) Alcohol (unspecified)	g	2,77E-05	0,00E+00	9,10E-08	0,00E+00	2,76E-05
(w) Aldehyde (unspecified)	g	6,21E-07	5,34E-09	1,78E-08	0,00E+00	5,98E-07
(w) Alkane (unspecified)	g	1,79E-03	3,68E-04	1,24E-03	0,00E+00	1,80E-04
(w) Alkene (unspecified)	g	1,65E-04	3,39483E-05	1,15E-04	0,00E+00	1,66E-05
(w) Aluminium (Al3+)	g	2,04E-02	3,33E-03	5,69E-05	2,31E-04	1,68E-02
(w) Aluminium Hydroxide (Al(OH)3)	g	4,83E-07	0	1,06E-09	0,00E+00	4,82E-07
(w) Ammonia (NH4+, NH3, as N)	g	9,87E-02	1,88E-02	8,16E-03	1,47E-02	5,70E-02
(w) AOX (Adsorbable Organic Halogens)	g	1,48E-03	6,60E-06	2,03E-05	1,45E-03	4,80E-06
(w) Aromatic Hydrocarbons (unspecified)	g	7,25E-03	1,47E-03	4,97E-03	0,00E+00	8,04E-04
(w) Arsenic (As3+, As5+)	g	4,23E-05	3,26E-06	4,03E-06	2,78E-07	3,47E-05
(w) Barium (Ba++)	g	3,54E-02	0,00708258	2,39E-02	0,00E+00	4,38E-03
(w) Barytes	g	2,06E-02	1,77E-04	5,90E-04	0,00E+00	1,98E-02
(w) Benzene (C6H6)	g	0,00179223	0,000367905	0,00124377	6,57218E-11	0,00018055
(w) BOD5 (Biochemical Oxygen Demand)	g	1,38E+00	2,96E-01	4,35E-04	1,50E-01	9,33E-01
(w) Boric Acid (H3BO3)	g	5,63E-04	0,00E+00	1,35E-06	0,00E+00	5,61E-04
(w) Boron (B III)	g	2,24E-04	4,59E-05	1,55E-04	0,00E+00	2,25E-05
(w) Bromates (BrO3-)	g	4,44E-04	3,98E-06	0,00E+00	4,40E-04	0,00E+00
(w) Cadmium (Cd++)	g	1,40232E-05	3,05069E-06	6,70356E-06	1,04783E-08	4,25849E-06
(w) Calcium (Ca++)	g	8,17E-01	9,46E-02	3,07E-01	3,67E-01	4,79E-02
(w) Carbonates (CO3--, HCO3-, CO2, as C)	g	2,11E-01	4,67E-02	1,64E-06	1,64E-01	5,23E-04
(w) Cerium (Ce++)	g	1,35E-05	2,82E-06	9,54E-06	0,00E+00	1,15E-06
(w) Cesium (Cs++)	g	1,16E-07	0,00E+00	0,00E+00	0,00E+00	1,16E-07

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(w) Chlorates (ClO3-)	g	0,256559	0,00125998	0	0,255299	0
(w) Chlorides (Cl-)	g	5,74E+01	2,40E+00	4,94E+00	4,90E+01	1,04E+00
(w) Chlorinated Matter (unspecified, as Cl)	g	3,28E-03	2,81E-05	9,39E-05	0,00E+00	3,16E-03
(w) Chlorine (Cl2)	g	3,38E-03	9,32E-06	8,20E-10	3,37E-03	0,00E+00
(w) Chloroform (CHCl3, HC-20)	g	3,51E-09	3,01E-11	1,01E-10	0,00E+00	3,38E-09
(w) Chromate (CrO4--)	g	1,80E-10	8,90E-11	9,06E-11	0,00E+00	0,00E+00
(w) Chromites (CrO3-)	g	4,84E-12	2,40E-12	2,44E-12	0,00E+00	0,00E+00
(w) Chromium (Cr III)	g	1,53E-05	1,31E-07	4,37E-07	0,00E+00	1,47E-05
(w) Chromium (Cr III, Cr VI)	g	2,59E-04	6,95E-06	2,31E-05	3,25E-09	2,29E-04
(w) Chromium (Cr VI)	g	2,99E-10	2,46E-12	8,22E-12	0,00E+00	2,89E-10
(w) Cobalt (Co I, Co II, Co III)	g	9,40856E-07	8,08742E-09	2,70171E-08	0	9,05752E-07
(w) COD (Chemical Oxygen Demand)	g	1,94E+01	2,59E+00	1,44E-02	1,43E+01	2,47E+00
(w) Copper (Cu+, Cu++)	g	4,28E-03	2,51E-03	1,36E-05	1,69E-03	6,92E-05
(w) Cyanide (CN-)	g	7,80E-05	7,36E-06	2,06E-05	8,79E-08	4,99E-05
(w) Dichloroethane (1,2-CH2ClCH2Cl)	g	0,00214804	8,71E-07	0,00E+00	2,15E-03	0,00E+00
(w) Dioxins (unspecified)	g	7,96593E-06	9,76868E-07	0	6,98906E-06	0
(w) Dissolved Matter (unspecified)	g	2,13E+01	1,98E-01	1,92E-04	2,16E+01	-4,53E-01
(w) Dissolved Organic Carbon (DOC)	g	1,19E-03	9,95E-06	3,32E-05	0,00E+00	1,15E-03
(w) Edetic Acid (EDTA, C10H16N2O8)	g	9,55E-07	0,00E+00	2,30E-09	0,00E+00	9,52E-07
(w) Ethyl Benzene (C6H5C2H5)	g	3,29E-04	6,79E-05	2,30E-04	0,00E+00	3,12E-05
(w) Fluorides (F-)	g	6,08E-04	1,66E-04	1,01E-04	5,35E-06	3,35E-04
(w) Formaldehyde (CH2O)	g	4,44E-11	3,82E-13	1,27615E-12	0	4,2783E-11
(w) Halogenated Matter (organic)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(w) Hexachloroethane (C2Cl6)	g	6,19E-15	5,32E-17	1,78E-16	0,00E+00	5,95E-15
(w) Hydrazine (N2H4)	g	4,39E-07	0,00E+00	1,05E-09	0,00E+00	4,38E-07
(w) Hydrocarbons (unspecified)	g	-1,02E-01	4,04E-02	3,29E-08	3,87E-03	-1,46E-01
(w) Hypochlorite (ClO-)	g	1,05E-06	9,06E-09	3,03E-08	0,00E+00	1,01E-06
(w) Hypochlorous Acid (HClO)	g	1,05E-06	9,06E-09	3,03E-08	0,00E+00	1,01E-06
(w) Inorganic Dissolved Matter (unspecified)	g	3,86E-04	2,32E-07	8,40E-07	0,00E+00	3,85E-04
(w) Iode (I-)	g	1,37E-03	0,000282798	9,56E-04	0,00E+00	1,27E-04
(w) Iron (Fe++, Fe3+)	g	2,32E-02	9,76E-04	1,20E-03	5,15E-04	2,05E-02
(w) Lead (Pb++, Pb4+)	g	3,96E-04	1,59E-05	5,18E-06	7,53E-06	3,68E-04
(w) Lithium Salts (Lithine)	g	4,90E-08	0	1,18E-10	0,00E+00	4,89E-08
(w) Magnesium (Mg++)	g	1,43E-02	2,42E-03	7,97E-03	5,56E-04	3,37E-03
(w) Manganese (Mn II, Mn IV, Mn VII)	g	1,55E-03	1,52E-04	4,65E-04	4,86E-08	9,38E-04
(w) Mercury (Hg+, Hg++)	g	2,58E-05	1,57324E-06	3,98335E-08	2,31857E-05	9,9461E-07

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(w) Metals (unspecified)	g	-1,82E-01	6,58E-02	6,03E-07	4,36E-02	-2,91E-01
(w) Methane (CH4)	g	0,00128514	0,00E+00	0	0	0,00128514
(w) Methyl tert Butyl Ether (MTBE, C5H12O)	g	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(w) Methylene Chloride (CH2Cl2, HC-130)	g	2,38E-05	8,64E-08	2,89E-07	0,00E+00	2,34E-05
(w) Molybdenum (Mo II, Mo III, Mo IV, Mo V, Mo VI)	g	3,67E-05	1,18E-06	4,08E-06	0,00E+00	3,14E-05
(w) Morpholine (C4H9NO)	g	4,64E-06	0,00E+00	1,12E-08	0,00E+00	4,63E-06
(w) Nickel (Ni++, Ni3+)	g	1,24E-03	1,18382E-05	2,32321E-05	0,00112371	7,77136E-05
(w) Nitrate (NO3-)	g	1,54E-01	1,40E-01	1,44E-02	6,54E-03	-7,17E-03
(w) Nitrite (NO2-)	g	2,64E-07	2,25E-09	7,51E-09	0,00E+00	2,54E-07
(w) Nitrogenous Matter (Kjeldahl, as N)	g	1,96E-04	0,00E+00	5,34E-07	0,00E+00	1,95E-04
(w) Nitrogenous Matter (unspecified, as N)	g	4,32E-02	0,0280379	0,00203948	0,0175602	-0,00448693
(w) Oils (unspecified)	g	0,0665521	7,12E-02	0,00810354	0,00888855	-0,0215911
(w) Organic Dissolved Matter (aliphatic)	g	0	0,00E+00	0	0	0
(w) Organic Dissolved Matter (aromatic)	g	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
(w) Organic Dissolved Matter (chlorinated)	g	0,000736802	6,83E-05	1,03646E-09	0,000662879	5,59598E-06
(w) Organic Dissolved Matter (unspecified)	g	8,90E-02	0,0685473	1,07E-07	2,05E-02	3,07E-05
(w) Organic Matter (unspecified)	g	0,166903	7,00E-05	1,10E-10	1,67E-01	0,00E+00
(w) Organo-silicon (unspecified)	g	2,90363E-16	2,65E-16	0,00E+00	2,57E-17	0,00E+00
(w) Organo-tin as Sn (unspecified)	g	1,02E-05	7,96E-08	0,00E+00	1,01E-05	0,00E+00
(w) Oxalic Acid ((COOH)2)	g	1,91E-06	0,00E+00	4,59E-09	0,00E+00	1,90E-06
(w) Phenol (C6H5OH)	g	1,24E-02	0,0105468	1,11E-03	5,58E-04	1,71E-04
(w) Phosphates (PO4 3-, HPO4--, H2PO4-, H3PO4, as P)	g	9,58E-04	7,24E-08	2,58897E-07	0	0,000957233
(w) Phosphorous Matter (unspecified, as P)	g	1,35E-01	1,01E-01	0,00E+00	3,39E-02	0,00E+00
(w) Phosphorus (P)	g	5,72E-05	1,18E-05	3,97E-05	0,00E+00	5,71E-06
(w) Phosphorus Pentoxide (P2O5)	g	1,08E-06	5,69E-09	5,81E-09	0,00E+00	1,07E-06
(w) Polycyclic Aromatic Hydrocarbons (PAH, unspecified)	g	0,000178627	3,68E-05	0,000124297	0	1,75643E-05
(w) Polycyclic Aromatic Hydrocarbons (unspecified)	g	0	0	0	0	0
(w) Potassium (K+)	g	9,71E-02	1,32E-02	4,22E-02	3,46E-02	7,05E-03
(w) Rubidium (Rb+)	g	1,37E-04	2,82798E-05	9,56E-05	0,00E+00	1,27E-05
(w) Salts (unspecified)	g	0,0668915	6,68E-06	1,47E-05	0,00E+00	6,69E-02
(w) Saponifiable Oils and Fats	g	6,66E-02	1,38E-02	4,67E-02	0,00E+00	6,19E-03
(w) Selenium (Se II, Se IV, Se VI)	g	3,27E-05	1,18E-06	4,06E-06	0,00E+00	2,75E-05

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(w) Silicon Dioxide (SiO2)	g	3,60E-06	3,10E-08	1,04E-07	0,00E+00	3,47E-06
(w) Silver (Ag+)	g	8,19403E-06	1,69678E-06	5,73652E-06	0	7,60728E-07
(w) Sodium (Na+)	g	33,2118	1,39535	2,99E+00	2,83E+01	5,42E-01
(w) Strontium (Sr II)	g	0,0824275	0,0170209	0,0575428	5,77313E-05	0,00780605
(w) Sulphate (SO4--)	g	8,59E+00	3,93E+00	8,25E-02	3,53E+00	1,05E+00
(w) Sulphide (S--)	g	1,25E-03	8,73E-04	1,55E-04	2,01E-04	2,29E-05
(w) Sulphite (SO3--)	g	1,13E-06	1,49E-10	3,88E-09	0,00E+00	1,13E-06
(w) Sulphurated Matter (unspecified, as S)	g	3,81E-09	5,33E-10	1,80392E-09	0	1,47703E-09
(w) Suspended Matter (organic)	g	0	0	0	0	0
(w) Suspended Matter (unspecified)	g	9,14E+00	1,99E+00	2,59E-03	6,97E+00	1,79E-01
(w) Tars (unspecified)	g	1,62E-09	2,39E-10	8,02E-10	0,00E+00	5,78E-10
(w) Tetrachloroethylene (C2Cl4)	g	1,49E-07	1,30E-13	4,34E-13	0,00E+00	1,49E-07
(w) Tin (Sn++, Sn4+)	g	1,06E-07	0,00E+00	3,14E-10	0,00E+00	1,05E-07
(w) Titanium (Ti3+, Ti4+)	g	5,46649E-05	3,25051E-07	1,14055E-06	0	5,31993E-05
(w) TOC (Total Organic Carbon)	g	2,10E-01	1,00E-01	7,03E-02	1,20E-02	2,76E-02
(w) Toluene (C6H5CH3)	g	1,50E-03	3,06E-04	1,03E-03	0,00E+00	1,62E-04
(w) Tributyl Phosphate ((C4H9)3PO4, TBP)	g	1,80E-05	0,00E+00	0,00E+00	0,00E+00	1,80E-05
(w) Trichloroethane (1,1,1-CH3CCl3)	g	3,41E-11	2,93E-13	9,79E-13	0,00E+00	3,28E-11
(w) Trichloroethylene (CCl2CHCl)	g	1,84E-07	8,06E-12	2,69E-11	0,00E+00	1,84E-07
(w) Triethylene Glycol (C6H14O4)	g	1,16E-03	9,95E-06	3,32E-05	0,00E+00	1,11E-03
(w) Vanadium (V3+, V5+)	g	1,11E-04	1,18E-06	4,32E-06	0,00E+00	1,06E-04
(w) Vinyl Chloride (CH2CHCl)	g	1,01E-02	4,28E-06	3,67E-12	1,01E-02	0,00E+00
(w) VOC (Volatile Organic Compounds)	g	0,00477102	0,000987961	0,00334012	0	0,00044294
(w) Water (unspecified)	litre	2,83095	0,000180538	0,000187748	0	2,83058
(w) Water: Chemically Polluted	litre	5,54152	0,0049674	0,0164508	0	5,52011
(w) Water: Thermally Polluted (only)	litre	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(w) Xylene (C6H4(CH3)2)	g	1,16E-02	2,66E-03	8,99E-03	0,00E+00	0,00E+00
(w) Zinc (Zn++)	g	0,00165249	1,25E-03	4,05876E-05	8,13292E-05	0,000278555
(wr) Americium (Am241)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Antimony (Sb124)	kBq	5,15059E-08	0,00E+00	5,15059E-08	0	0
(wr) Antimony (Sb125)	kBq	0	0,00E+00	0	0	0
(wr) Carbon (C14)	kBq	0	0,00E+00	0	0	0
(wr) Cerium (Ce144)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Cesium (Cs134)	kBq	4,53E-08	0,00E+00	4,53E-08	0,00E+00	0,00E+00
(wr) Cesium (Cs137)	kBq	6,64E-08	0,00E+00	6,64E-08	0,00E+00	0,00E+00
(wr) Cobalt (Co58)	kBq	1,49E-07	0,00E+00	1,49E-07	0,00E+00	0,00E+00

Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
(wr) Cobalt (Co60)	kBq	9,3083E-08	0,00E+00	9,3083E-08	0	0
(wr) Curium (Cm alpha)	kBq	0	0,00E+00	0	0	0
(wr) Curium (Cm244)	kBq	0	0,00E+00	0	0	0
(wr) Iodine (I129)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Iodine (I131)	kBq	5,65E-09	0,00E+00	5,65E-09	0,00E+00	0,00E+00
(wr) Manganese (Mn54)	kBq	7,44664E-09	0,00E+00	7,44664E-09	0	0
(wr) Manganese (Mn55)	kBq	0	0,00E+00	0	0	0
(wr) Mix (Zr95, Nb95)	kBq	0	0,00E+00	0	0	0
(wr) Neptunium (Np237)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu alpha XXX)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu238)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu239)	kBq	0	0,00E+00	0	0	0
(wr) Plutonium (Pu241 beta)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Protactinium (Pa234m)	kBq	2,27E-07	0	2,27E-07	0,00E+00	0,00E+00
(wr) Radioactive Substance (unspecified)	kBq	2,15E-11	1,07E-11	1,09E-11	0,00E+00	0,00E+00
(wr) Radium (Ra224)	kBq	6,19E-04	0,000141399	4,78E-04	0,00E+00	0,00E+00
(wr) Radium (Ra226)	kBq	1,67E-03	2,83E-04	1,39E-03	0,00E+00	0,00E+00
(wr) Radium (Ra228)	kBq	0,00123888	2,83E-04	0,000956087	0	0
(wr) Ruthenium (Ru106)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Silver (Ag110m)	kBq	2,23399E-07	0,00E+00	2,23399E-07	0	0
(wr) Strontium (Sr90)	kBq	0	0,00E+00	0	0	0
(wr) Technetium (Tc99)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Thorium (Th228)	kBq	2,48E-03	5,66E-04	1,91E-03	0,00E+00	0,00E+00
(wr) Thorium (Th230)	kBq	2,13E-05	0,00E+00	2,13E-05	0,00E+00	0,00E+00
(wr) Thorium (Th234)	kBq	2,27E-07	0	2,27E-07	0,00E+00	0,00E+00
(wr) Tritium (H3)	kBq	0,00271164	0,00E+00	0,00271164	0	0
(wr) Uranium (U alpha XXX)	kBq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
(wr) Uranium (U234)	kBq	7,50E-06	0,00E+00	7,50E-06	0,00E+00	0,00E+00
(wr) Uranium (U235)	kBq	3,26E-07	0,00E+00	3,26E-07	0,00E+00	0,00E+00
(wr) Uranium (U238)	kBq	7,04129E-06	0	7,04129E-06	0	0
Hydrochloric Acid (HCl, 100%)	kg	0,00E+00	0	0,00E+00	0,00E+00	0,00E+00
Recovered Energy	MJ	1,06E+01	9,80456	0,00E+00	8,24E-01	0,00E+00
Recovered Energy (total)	MJ	10,6281	9,80E+00	0	0,823551	0
Recovered Matter (total)	kg	3,93E-02	0,015864	1,71593E-06	0,000695762	0,0227661
Recovered Matter (unspecified)	kg	2,02E-02	1,59E-02	1,69E-06	6,96E-04	3,66E-03
Recovered Matter: Ash	kg	0,00E+00	0	0	0	0

	Flow	Units	Plastic	Plastic stoppers production	Transport	Bottling	End of life
	Recovered Matter: Cardboard	kg	0	0,00E+00	0	0	0
	Recovered Matter: Iron Scrap	kg	2,67432E-08	0	2,67432E-08	0	0
	Recovered Matter: Metals (unspecified)	kg	0	0,00E+00	0	0	0
	Recovered Matter: Non Ferrous Metals	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Others for Energy	kg	0	0,00E+00	0	0	0
	Recovered Matter: Paraffin Wax	kg	0	0,00E+00	0	0	0
	Recovered Matter: Steel Scrap	kg	0,000625555	0,00E+00	0	0	0,000625555
	Recovered Matter: Tall Oil	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Recovered Matter: Turpentine	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Silica (SiO2)	kg	0	0	0	0	0
	Waste (hazardous)	kg	0,0215533	1,76E-02	9,53534E-05	0,00382311	-1,46511E-05
	Waste (incineration)	kg	3,31E-05	0,00E+00	0,00E+00	0,00E+00	3,31E-05
	Waste (municipal and industrial)	kg	0,245283	0,139369	6,01794E-08	-0,0047738	0,110688
	Waste (municipal and industrial, to incineration)	kg	0,00E+00	0,00E+00	0	0	0
	Waste (tailings)	kg	1,00E-02	5,92E-03	0,00E+00	4,09E-03	0,00E+00
	Waste (total)	kg	5,84E+00	4,93E-01	4,77E-04	7,29E-02	5,27E+00
	Waste (unspecified)	kg	2,08E-01	1,96E-01	1,39E-05	1,17E-02	5,82E-04
	Waste (unspecified, to incineration)	kg	1,03E-02	5,88E-03	5,27E-05	4,41E-03	0,00E+00
	Waste: Highly Radioactive (class C)	kg	1,22423E-06	0,00E+00	6,60E-09	0,00E+00	1,22E-06
	Waste: Intermediate Radioactive (class B)	kg	9,30E-06	0,00E+00	0	0	9,29968E-06
	Waste: Low Radioactive (class A)	kg	0,000183243	1,72501E-05	5,85433E-05	0	0,00010745
	Waste: Mineral (inert)	kg	2,50E-02	1,04E-02	2,26E-04	9,07E-03	5,33E-03
	Waste: Mining	kg	0,103847	0,00E+00	0,000342022	0	0,103505
	Waste: Non Mineral (inert)	kg	5,16E+00	2,05E-06	6,93E-06	0,00E+00	5,16E+00
	Waste: Non Toxic Chemicals (unspecified)	kg	2,17E-02	1,77E-02	1,2683E-09	0,009862	-0,00584407
	Waste: Radioactive	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Waste: Radioactive (unspecified)	kg	1,32887E-05	2,75177E-06	9,30323E-06	0	1,23371E-06
	Waste: Slags and Ash (unspecified)	kg	0,131527	0,100042	1,44445E-05	0,0346794	-0,00320801
	Waste: Treatment	kg	0,0057748	0	0	0	0,0057748
Reminders:	E Feedstock Energy	MJ	295,41	314,1	-0,00049617	24,0122	-42,7018
	E Fuel Energy	MJ	219,048	187,087	4,24874	45,0781	-17,3659
	E Non Renewable Energy	MJ	496,747	485,456	4,24768	67,3814	-60,3378
	E Renewable Energy	MJ	17,7135	15,7315	0,000568525	1,70899	0,272443
	E Total Primary Energy	MJ	514,462	501,187	4,24824	69,0904	-60,0637
	Electricity	MJ elec	39,4668	35,4852	0,0112104	0	3,97037

Table 24: Inventory of the plastic closures LCA