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INVENTORY ANALYSIS FOR THE LIFE CYCLE ASSESSMENT OF PACKAGINGS FOR SOFT DRINKS

ANÁLISE DO INVENTÁRIO PARA AVALIAÇÃO DO CICLO DE VIDA DE EMBALAGENS PARA REFRIGERANTES

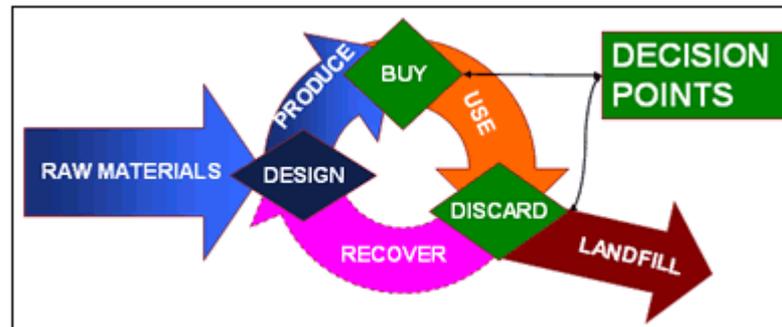


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Academic Work

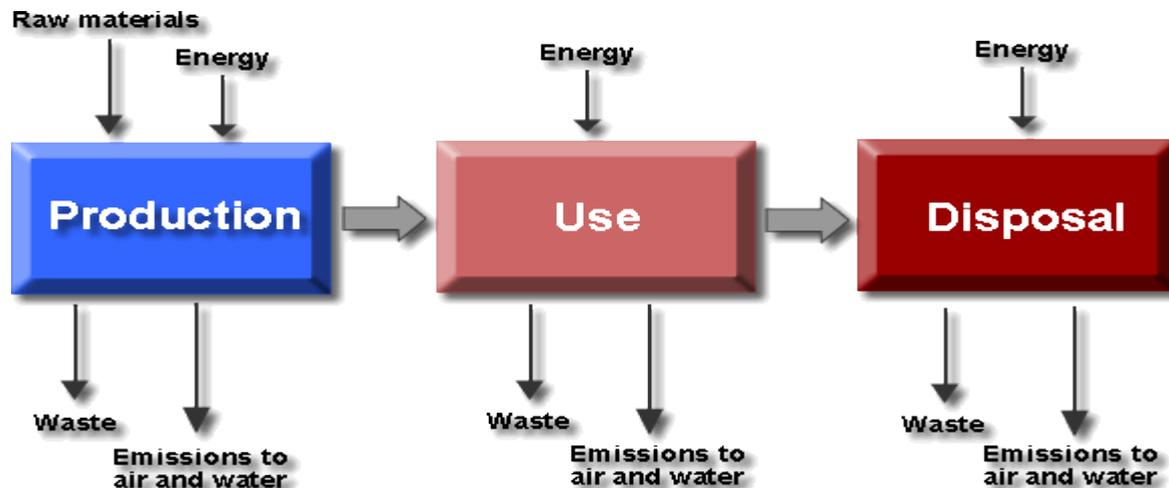
Introduction

- Industries have paid more attention to the environmental properties of their products also focusing on distinguishing them to enlarge the market share of the corporations.



Introduction

- Several management techniques have been applied for the assessment of products' environmental impacts, such as, LCA – Life Cycle Assessment, which studies the complex interaction between environment and product.



Introduction

- The purpose of this work is an analysis of both energy and mass balance for top three sorts of packagings for soft drinks:

aluminium can, PET bottles and glass ones,

- with national data, using the LCA tool.

Introduction

- The project consisted in identifying and quantifying the main variables included on the packagings production process, like the use of energy and natural resources, besides emissions and waste produced during the whole life cycle of these packagings.

Introduction

- The inventory subject includes showing critical points for environmental control as a way of helping on decision-making to optimize processes, changes on product focusing cleaner production and prevention of environmental pollution.

Methodology

- The work was distributed into three main stages:
 1. description of the material sorts and included processes and the survey study of life cycle assessment of each one of the proposed packagings;
 2. data collection in packagings companies and also in the literature and;
 3. achieved information digest.

Methodology

- The main objective consisted in pointing out the critical points for environmental control as a way of helping on decision-making processes, changes on product focusing cleaner production and prevention of environmental pollution.

Methodology

Table 1 – Bottling capacity and mass (mean values) of studied packagings

| Type of packaging | Bottling capacity (mL) | Mass (g) | Number of packagings in accordance with the functional unity taken (1000 L) |
|-------------------|------------------------|----------|---|
| Glass bottle | 290,0 | 386,2 | 3448 |
| Aluminium can | 350,0 | 14,3 | 2857 |
| PET bottle | 2000,0 | 50,0 | 500 |

Methodology

The study included since the stages of raw-materials extraction to produce the packagings, the packaging not quite done (can, PET preform and glass bottle), its use in the soft drinks industry until the stage of recycling processes of each one of them.

Methodology

The achieved informations were managed within significant, market-share leaders national enterprises (regarding to its production volume and to its representativity in the production sector), which some of these are multinational companies.

The provided informations are in accordance with the productive capacity of each company.



Methodology

The choice of environmental aspects and the division into groups used on the identification and quantification of the environmental impacts of each studied process were based upon their relevance and extent in respect to potential effects they cause on the environment.

Methodology

- The energy, mass and global balances were calculated for all processes of the packagings' LCA study after the working up of all processes issues and in accordance with the settled variables in the study.
- The gained results allowed comparing and estimating which environmental impacts would be more relevant.

Results and Discussion

- A relevant fact which must be considered is:
- the choice's and supposition's types which are done in LCA studies are subjective in the most of the cases (for example, the systems limits, the selection of data sources and the impact categories).

Results and Discussion

- That means to say that the models can be limited to a predefined period of time or to a local condition.
- The data collection period was 1 year in this study.

Results and Discussion

- By analysing the results, it was showed that consumption of natural resources is associated mainly to transport and to generation of steam from boilers.
- High consumption of electric power is related basically to the equipments running.

Results and Discussion

- The stages which include cleaning processes are essential responsible for high consumption of water and for generation of wastewater from the processes .



Results and Discussion

- The fuel burning in the processes is the main source of atmospheric emissions and generates pollutants CO₂, CO, NO_x, SO₂, VOC's, particulates, among other ones.



Results and Discussion

- The loss of products, secondary packagings, ashes from fuel burning are examples more typical of solid wastes generated.

Results and Discussion

- The last part of this stage consisted on the quantification of environmental aspects related to the life cycle processes of the three studied packagings.
- In accordance with the gained results, the quantification summary of environmental aspects of the studied packagings life cycle is showed in the Table 2 and in the Figure 1.

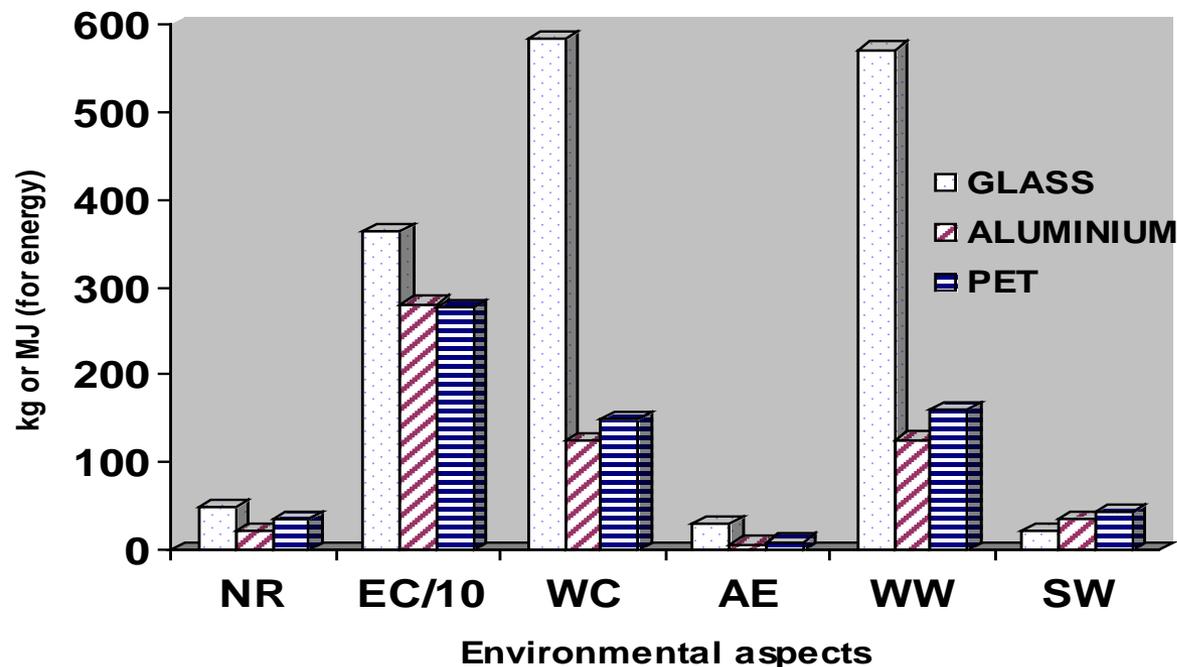
Results and Discussion

Table 2 – Brief quantification of environmental aspects of the studied packagings life cycle in accordance with the settled functional unity.

| Environmental aspect | GLASS BOTTLES (recycling rate 25%) | ALUMINIUM CANS (recycling rate 90%) | PET BOTTLES (recycling rate 40%) |
|---------------------------------|---------------------------------------|--|-------------------------------------|
| Material mass (kg) | 1331,70 | 40,83 | 25,00 |
| NR – Natural resources (kg) | 48,42 | 22,14 | 34,38 |
| EC – Energy consumption (MJ) | 3638,64 | 2808,23 | 2768,83 |
| WC – Water consumption (kg) | 584,39 | 124,70 | 148,96 |
| AE – Atmospheric emissions (kg) | 29,99 | 6,70 | 9,29 |
| WW – Wastewater (kg) | 571,55 | 125,80 | 159,12 |
| SW – Solid wastes (kg) | 21,59 | 35,11 | 43,70 |

Results and Discussion

Figure 1 – Quantification summary of environmental aspects of the studied packagings life cycle in accordance with the settled functional unity



Conclusions

- In accordance with the studied systems, the results showed that glass bottle is the packaging which more contribute negatively to the environment.
- Aluminium can was the one which showed the best scenery, in other words, the lowest negative contribution to the environment.

Conclusions

- The highest consumption of water and wastewater emission occurs in the glass bottle life cycle, due to reuse cycles and to its large constitution in the stage of recycling of the packaging life cycle.

Conclusions

- It is relevant to highlight that, related to the consumption of natural resources and energy consumption, the PET bottle is the packaging which shows the worst scenery among the results.
- The same was noticed for atmospheric emissions.

Conclusions

- Amongst all top points to be improved in the production stages there are the reuse of water from bottles cleaning process and the reduction of process losses, where the quantities of generated solid wastes were remarkable in all sceneries.

Conclusions

- The emission of VOC's for PET bottles is high in the stages of oil extraction and refining operations, which makes it necessary installing captivation systems of these emissions.

Conclusions

- In the aluminium cans life cycle, the optimization must be focused on the alumina production stage, in order to reduce the quantity of generated industrial waste .

References

- ABNT – ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. *Gestão Ambiental: Avaliação do ciclo de vida - princípios e estrutura – NBR ISO 14040*. Rio de Janeiro – RJ. ABNT. 10 p., 2001.
- BRENTROP, F., KUSTERS, J., KUHLMANN, H., LAMMEL, J.. *Environmental impact assessment of agricultural production systems using the life cycle assessment methodology*: I. Theoretical concept of a LCA method tailored to crop production. Elsevier Science B.V.. Amsterdam – Netherlands. v. 20 (3), p. 247-264, 2004.
- COLTRO, L. *A aplicação da Análise de Ciclo de Vida no Brasil*. Revista Meio ambiente Industrial. São Paulo – SP. Edição: 42. n. 41, Ano: VII, p. 72-80, 2003.
- FABR, A. R. *Comparação do consumo de energia e emissão de CO₂ entre garrafas de PET e de vidro utilizando análise ambiental do ciclo de vida*. Campinas. Dissertação (Mestrado em Engenharia Mecânica) Universidade Estadual de Campinas, 143 p, 2004..
- JÖNSON, G. *LCA – A tool for measuring environmental performance*. Surrey: Pira International. United Kingdom. 190 p, 1996.
- KNIGHT, A.; WOLFE, J.; POON, J. *Life cycle assessment*. Toronto: ICF Kaiser Canadá, 35 p, 1996.
- MOURAD, A.N., GARCIA, E.E.C., VILHENA, A. *Avaliação do Ciclo de Vida: princípios e aplicações*. CETEA/ITAL : Campinas-SP, 92 p, 2002.
- SETAC - Society of Environmental Toxicology and Chemistry. *Conceptual Framework for Life-Cycle Impact Assessment*. SETAC Press. Pensacola-FL. 188 p, 1993.
- SILVA, P.G.S. *Inovação ambiental na gestão de embalagens de bebidas em Portugal*. Lisboa. Dissertação (Mestrado em Engenharia e Gestão de Tecnologia). Instituto Superior Técnico. Universidade Técnica de Lisboa, 159 p, 2002.



THANK YOU!

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