DEVELOPMENT OF CHARACTERIZATION FACTORS FOR CALCULATING THE DEPLETION OF ABIOTIC RESOURCES IN RAW MATERIALS USED IN THE MANUFACTURE OF CERAMIC PRODUCTS IN THE CONTEXT OF LIFE CYCLE ANALYSIS

Daniel Garraín, Juan Gasch, Vicente Franco, Carlos Muñoz, Rosario Vidal

Design Engineering Group, Mechanical Engineering and Construction Group, Universitat Jaume I, Av. Sos Baynat, s/n, E-12071 Castellón (Spain)

1. INTRODUCTION: LCA AND THE ABIOTIC RESOURCE DEPLETION CATEGORY

One of the most widely accepted tools by the scientific community for evaluating environmental impact is Life Cycle Analysis (LCA), which studies environmental aspects and the potential impact throughout the lifecycle of a product or activity. Through this method, the composition and quantities of pollutants generated and resources consumed can be assessed in terms of their environmental impact and grouped into a small number of environmental categories.

The abiotic resource depletion category is among those most widely discussed by the international scientific community specialising in LCA, and has led to the appearance of different available and operational methods for the development of characterization and normalization factors. Natural resources are considered part of the abiotic resources group (including energy resources) which may be considered as "non-live". Depletion involves the use of both renewable and non-renewable abiotic resources, and depends on existing reserves and the extraction rates of specific resources, providing an indication of the severity of the depletion.

The method most commonly used as a reference is that developed by Dutch author Guinée and his colleagues (Guinée et al., 2002), which, as well as taking into account the reserves of each element, also takes into account the decrease or reduction ratio of the resource by calculating the abiotic depletion potential (ADP) or factor, measured in quantity of Sb equivalent per resource quantity. There are clearly a series of characterization factors which are easier to calculate than others. In the case of certain composites such as bauxite, arsenic trioxide and boric oxide, these have been obtained from elements such as aluminium, arsenic, and boron, which are much easier to calculate. Very few data are available in the literature, however, for calculating the ADP for the depletion of the raw materials used to manufacture ceramic products (clay, quartz, feldspar, dolomite, silicates, mica, carbonates, etc.), attributable to the difficulty of obtaining reference values.

The purpose of this study is to develop a preliminary ADP for the category of raw materials used to manufacture ceramic products, using the aforementioned method.

2. RESULTS AND DISCUSSION

The following table shows the calculated ADP values (for the world and for Spain) using the Guinée et al (2002) method for the following ceramic raw materials: feldspar, quartz, carbonates, and clays.

Raw material	Feldspar	Quartz	Carbonates	Clays
% in mass in the earth's crust	7	38	20	9
Last reserve (Mt)	5,72E+11	6,21E+11	1,91E+11	1,16E+11
World production (t)	1,81E+07	1,26E+05	2,83E+05	-
Spanish production (t)	6,00E+05	5,00E+03	2,00E+03	6,88E+04
World ADP (kg Sb eq)	**9,72E-09**	**5,74E-07**	**1,37E-07**	**-**
Spanish ADP (kg Sb eq)	**3,22E-11**	**2,28E-10**	**9,67E-10**	**8,93E-10**

Table 1.

The ADP values obtained for Spain were considerably lower, because they are related to world rather than domestic reserves. However, it must be noted that in the case of feldspar, use of the value calculated for Spain would be inaccurate due to the increase in imports of these materials from countries such as Turkey.

3. CONCLUSIONS

The development of new ADP is necessary for a more comprehensive study of LCA of products, as is the case with ceramic materials in the abiotic resources category, because to date, no ADP have been developed for their corresponding raw materials.

The results obtained are a step towards making a wider, regionalized LCA of ceramic products. However, it is necessary to develop a more comprehensive, more reliable databases of inventories or abiotic reserves in order to be able to develop new ADP, update stocks and even obtain regionalized ADP to encourage the reduction of the degree of uncertainty and increase the relevance and interpretability of the results of a certain LCA.

REFERENCES

[1] Guinée, J.B.; Gorrée, M.; Heijungs, R.; Huppes, G.; de Koning, A.; Wegener, A.; Suh, S.; Udo de Haes, H.; Bruijn, H.; Duin, R.V.; Huijbregts, M.A.J. (2002) "Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards", Kluwer Academic Publishers, Dordrecht, The Netherlands.