

Lifecycle Assessment of Hard Porcelain for Tableware Production

B. Berninger, M. Bär, K. Krebs, R. Tinter

Sustainable, resource-saving and environment-friendly production is an increasingly important topic for companies. On the one hand, because of the finite nature of numerous raw materials and, on the other hand, on account of the growing social acceptance with regard to environmental awareness and the demand for environmentally friendly produced products. This can be seen above all with the issue of climate change. Methods such as lifecycle assessment are increasingly important instruments in industrial practice to identify the environmental impact generated by the production or the entire lifecycle of a product. These studies are becoming more and more important in many different industrial sectors such as the automotive industry, energy generation or even tableware production to meet demands in existing markets and access new markets. Often the careful and selective use of raw materials and resources entails possibilities for financial savings. In addition, it offers a possibility for comparison of different products and manufacturing processes in respect of their environmental impact. Against this background, in this case, a lifecycle assessment was compiled at the porcelain manufacturer BHS tabletop AG (Fig. 1) based in Selb/DE.

A lifecycle assessment can, depending on the preceding definition, cover the complete lifecycle or also only a part of the lifecycle, like, for example, production. The framework for the compilation of a lifecycle assessment is defined by DIN EN ISO 14040 and 14044. It includes four components: Definition of the goal and scope of the study, inventory, impact assessment and interpretation.

Burkhard Berninger, Markus Bär
Ostbayerische Technische Hochschule
(OTH) Amberg-Weiden
92224 Amberg, Germany
www.oth-aw.de

Kurt Krebs, Roland Tinter
BHS tabletop AG
92637 Weiden, Germany
www.bhs-tabletop.de

Corresponding author: B. Berninger
E-mail: b.berninger@oth-aw.de

Keywords: lifecycle assessment,
porcelain production, environmental
relevance, energy efficiency,
environmental management

Manufacturing steps in the production of tableware from hard porcelain

The manufacturing steps involved in the production of tableware from hard porcelain are roughly outlined in Fig. 1. Depending on the article manufactured and production method, additional intermediate steps may be necessary.

The manufacture of decorated tableware also requires additional processing steps. Waste products produced in the course of the manufacturing process can often, following special processing steps, be reused directly in production and therefore recycled. As a result, it is possible to save on raw materials and resources. But even supposed waste like broken tableware is used, for example, in road construction. Numerous materials are therefore recycled instead of being disposed of as waste.

Compiling and performing the lifecycle assessment

The goal of the lifecycle assessment is to obtain an overview of the environmental impact caused by the production of tableware from hard porcelain. Consequently, the scope of the study is a gate-to-gate analysis (within the factory). It is therefore not an analysis of the complete lifecycle but



Fig. 1 Typical product from the BHS tabletop AG assortment (Source: BHS tabletop AG)

only the processes that take place within the factory. The system boundaries encompass all relevant manufacturing processes as shown in Fig. 2. Here only the input and output streams are shown that could be determined and used in the assessment.

These can vary depending on the manufacturing or shaping process. In the inventory, all material streams and their quantities that are within the system boundaries are determined, like, for example, raw materials, electricity, water, natural gas, compressed air and others. In the impact assessment, the impact categories to be analysed, like greenhouse effect, acidification, eutrophication, are defined. Moreover, the pollutants formed in the processes are classified into individual impact categories.

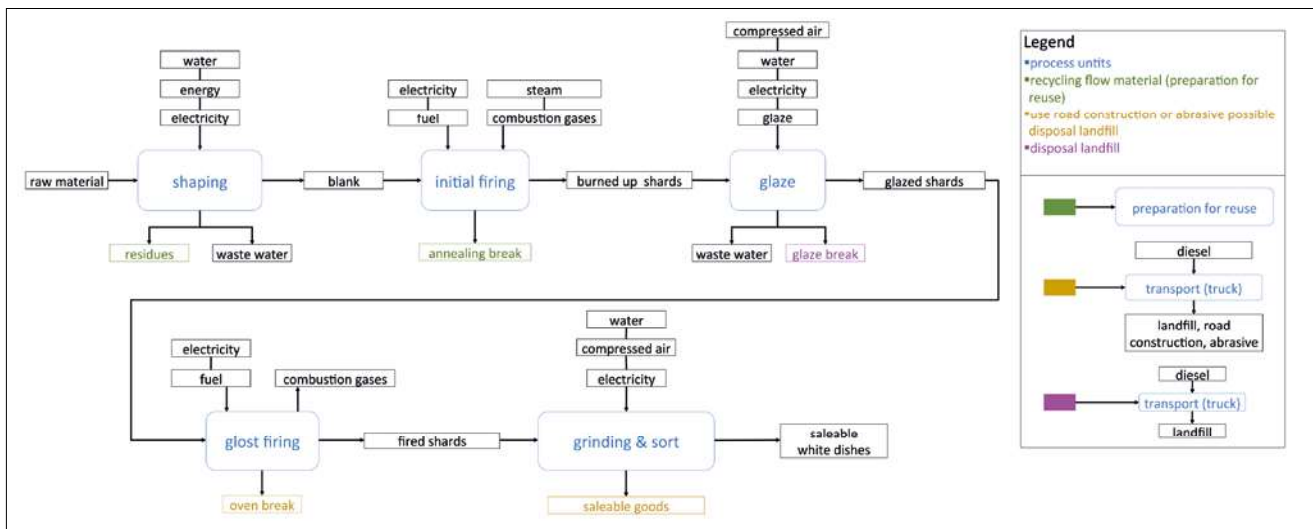


Fig. 2 Simplified overview of the system boundaries in the production of porcelain tableware (Source: BHS tabletop AG)

All substances that belong to one impact category have different values and related to a reference value. In the case of the greenhouse effect or climate change, carbon dioxide (CO₂) is the reference value, which is referred to as the CO₂ equivalents. In addition, in this project, the ozone depletion potential (stratospheric) [kg R11-equivalents], the photochemical ozone creation potential (low-lying) [kg ethylene equivalents], acidification potential [kg SO₂ equivalents], the eutrophication potential [kg phosphate equivalents] and the human toxicity potential [kg DCB-equivalents] are analysed. These environmental impacts were studied for differently applied shaping processes and production lines like ISO presses, jiggering and jollying and high-pressure casting, and decoration. There

are production lines in which, for example, only flatware or cups are made and such in which a wide range of different types of articles is produced. By way of example, in the following only the greenhouse potential is discussed.

To compile the lifecycle assessment, GaBi software from thinkstep AG was used. For interpretation, the values according to the LCIA-CML 2001 method were used.

Results of the lifecycle assessment

The interpretation of the greenhouse effect for the production of tableware from hard porcelain can be seen in Fig. 3. In this, the greenhouse potentials caused by the individual process units are plotted relative to 1 kg produced white tableware. It shows

that primarily from the processes in which firing is performed, the largest potential with around 79 % of the overall greenhouse potential of 3,23 kg CO₂ equivalents is derived. This is down to the large quantities of combustion gases caused by the fuels used (generally natural gas).

But the extraction of the natural gas used, and the pollutants formed that affect the greenhouse potential are also taken into consideration. However, shaping with 18,9 % also accounts for a non-negligible part of the greenhouse potential. This can be attributed to the high consumption of electricity and compressed air. In the generation of these, materials are used that contribute to the greenhouse potential. Under shaping come also the production and in-factory preparation of plastic bodies and slips from which the articles are moulded. Moreover, natural gas consumption from drying processes, which are necessary after many shaping processes for further processing, and the associated pollutants contribute to the greenhouse potential.

The comparison of the different production lines shows that the environmental impacts for production lines on which, for example, only flatware is produced, are lower than for the production lines on which wider ranges of articles are manufactured. That is attributed to the fact that for the production of just one sort of article the process parameters can be better optimised and adjusted. If the white tableware undergoes decoration, as a result further greenhouse potential is released.

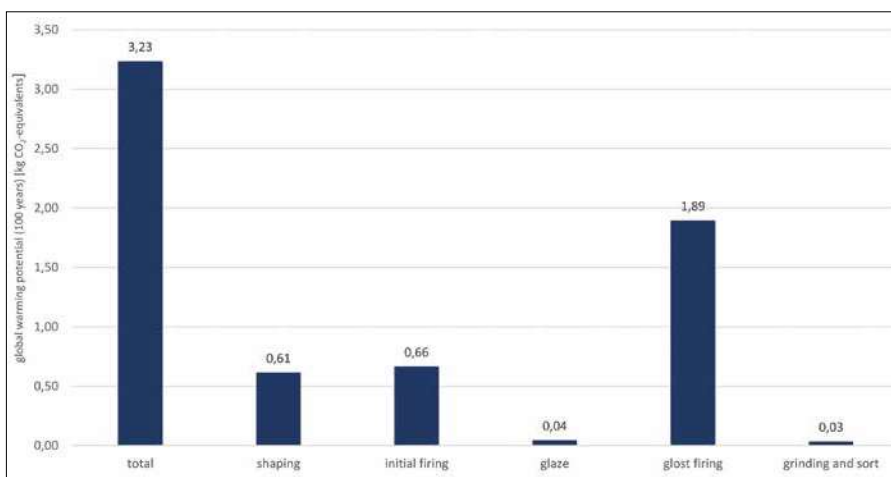


Fig. 3 Average greenhouse potential in the production of tableware relative to 1 kg of saleable white tableware (Source: BHS tabletop AG)



40 YEARS
INNOVATING

“Developing
Machinery and
Efficient Solutions
for the Heavy
Clay Industry”

 **metalcertima**
machinery and engineering



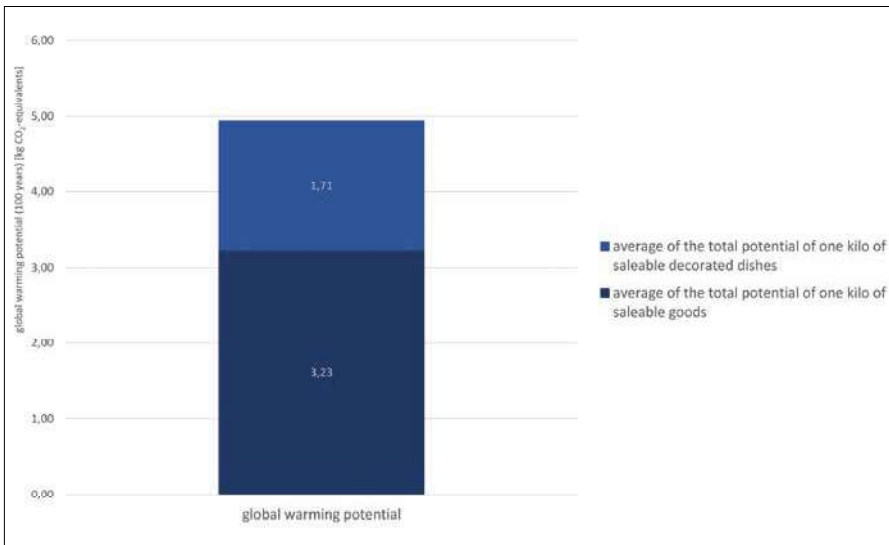


Fig. 4 The greenhouse potential (100) years for the production of white tableware and decoration, both relative to 1 kg saleable tableware (Source: BHS tabletop AG)

The greenhouse potential caused additionally by the decoration and that caused in the manufacturing of the white tableware are listed for comparison in Fig. 4. Both are based on the manufacture of 1 kg. In the figure it can be seen that for the production of decorated tableware around 65,4 % of the greenhouse potential caused is attributed to the production of the white tableware. The decoration is responsible for 34,6 % of the resulting greenhouse potential. In the decoration, the firing process and the combustion gases formed are the main cause of the greenhouse potential.

The interpretation shows that the production of decorated tableware has a higher greenhouse potential than the manufacture of white tableware. In addition, it is important to analyse all relevant processes as even supposedly low emitters can have considerable effects on the environment. The duration of use of the products must be taken into consideration. Porcelain products, with more than 2000 washing processes depending on the application, boast a very long lifetime, especially in comparison with single-use tableware.

Lifecycle assessment is an important instrument to identify the environmental impacts caused during the lifecycle of a product, especially the process stages in which large quantities or especially environmentally harmful pollutants are formed.

This gives the companies the possibility to specifically analyse the individual processes and develop minimization solutions, to make a contribution to the reduction of pollutant input and the resulting environmental impact.

References

- [1] Salmang, H.; Scholze, H.: Keramik. Berlin, Heidelberg 2007
- [2] Autorenkollektiv: Technologie der Feinkeramik. Leipzig 1970
- [3] Kaltschmitt, M.; Schebek, L.: Umweltbewertung für Ingenieure. Heidelberg 2015
- [4] Umweltbundesamt: Ökobilanz [Online] [Zitat vom: 09.03.2017] <https://www.umweltbundesamt.de/themen/wirtschaft-konsum/produkte/oekobilanz>
- [5] Friedel, H.: 100 Fragen zu Porzellan. Selb, Verband der Keramischen Industrie e.V., 22nd ed. 2013
- [6] Heinrich, J.G.; Gomes, C.M.: Einführung in die Technologie der Keramik. Lecture manuscript, TU Clausthal

If you could just **SHIFT** your kiln efficiency that easily...

With **IKCS** **Fire** and **Efficiency** are always side by side.

IKCS®
Interactive Kiln Control System

Watch the video
Scan the QR code

ceramifor.com

Save up to 45% in fuel consumption

CERAMIFOR
KILNS & EQUIPMENT

CERINNOV Group
TOMORROW'S SOLUTIONS TODAY

CENTRO 2020 **PORTUGAL 2020** **EUROPEAN UNION** **EUROPEAN COMMISSION** **Portugal 2020**