

## Summary (for external use)

In this screening LCA study the environmental impact of three alternative heating elements for coffee machines are compared by a screening based on the Life Cycle Assessment (LCA) framework. As such, the study does not comply to ISO 14040/14044 "Environmental management – Life cycle assessment" in terms of completeness, weighting of environmental aspects and the obligation for an external review. The results are reported in TNO-report "Screening LCA study on environmental impact of heating systems for coffee pod brew systems".

The company 'Ferro Techniek BV' has developed a ThickFilm heating element based on enamel technology (TF heating element). They commissioned this study to TNO in order to obtain insight in the environmental impact of the TF-heating element compared to a competitive boiler and a competitive thermo block.

In order to compare the three heating elements the functional unit has been defined as:

The production and end-of- life treatment of a heating element and the energy necessary to heat a total of 10000 cups of coffee (140ml) from 15°C to 80°C in one heating cycle for each cup.

The product data used for the three systems are provided by 'Ferro Techniek BV'. This concerns all amounts of materials used and the (estimated) energy used for construction by the manufacturers of the heating elements. Also actual energy use for preparing cup(s) of coffee with the three alternative elements is measured by 'Ferro Techniek BV' and used for calculation of the environmental impact. This is compared with calculated theoretical energy use by TNO for heating the water needed for the cup(s) of coffee. This means that the results presented are almost entirely based on data for the three competitive heating elements provided by Ferro Techniek BV.

The main results of this study are presented in Figure 1. The total environmental impact for the three alternative heating elements during lifetime (first three columns) is given in CML shadow costs (in EUR) for 11 different environmental impact categories (different colours). The environmental impacts of the three alternative heating elements are in the range between 10 EUR (TF-element) and 30 EUR (Thermo block).

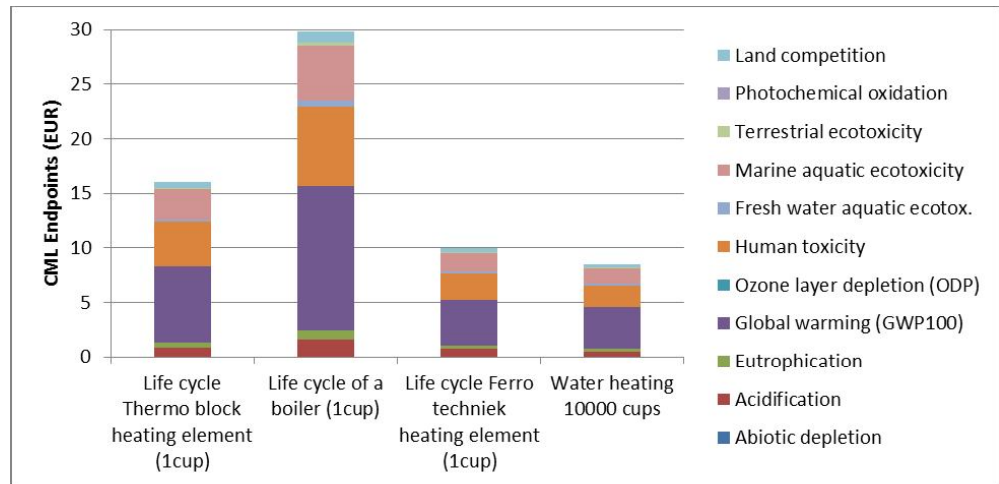


Figure 1 Impact of the three heating elements (1 cup per heating cycle) compared to the theoretical heating of water for the cups of coffee

As a reference the environmental impact of heating the water contained in the total of 10000 cups of coffee (8.5 EUR) is calculated by TNO and is based on the theoretical amount of electrical energy needed (fourth column). The main difference between the three heating elements is the amount of electricity used for the heating of the 10000 cups of water for the coffee. The most efficient heating element is the TF element, followed by the thermo block and the boiler.

The biggest environmental impact of all systems is caused by the energy use for heating water. For the TF-element total environmental impact during lifetime is almost completely caused by heating the water contained in the cups. For the thermo block additional energy is necessary for heating the high amount of mass of the element itself and in the case of the boiler additional energy is necessary for heating water not ending in the cups of coffee (the boiler is always heating water for two cups in the case only one cup at a time is needed).

The environmental impact of the production of the 'Ferro Techniek' heating element itself is also analysed and shows that about 50% of the impact of the element itself is caused by the thick film layer, and especially the palladium used in it.

The results of a sensitivity analysis make clear that none of the relevant changes in the assumptions resulted in a different relative position of the three alternatives regarding total environmental impact. If thermo block and boiler elements stay in standby mode the impact of additional energy consumed is increased with at least 20 EUR. The TF-element switches off automatically after brewing a cup of coffee. If two cups of coffee are brewed per heating cycle, the environmental impact of the three alternatives reduces to 10 EUR (TF-element), 12 EUR (thermo block) and 15 EUR (boiler). Recycling of the heating elements after lifetime instead of waste incineration has minor influence (less than 0.5 EUR) on the total environmental impact during life time for all alternatives although between 10% and 50% of the impact caused by production of the elements can be compensated by recycling the metals.