Material: Cumulative Energy Demand (CED) and Carbon Footprint (CF)

During the development of a new polypropylene (PP) composite material with bio-based fibres, which can be utilized for example in the automotive sector, different molding compounds were analysed regarding their influence on the production process for the evaluation of environmental performance.

By substituting a share of PP with bio-based fibres, the new composite material has different values in energy intensity (CED in MJ) and in Carbon Footprint (CF in kg/CO₂ equivalents) in comparison to neat PP, e.g. -15% MJ/kg and –20% kg/CO₂ equivalents.

Fibre reinforcement results in improved material characteristics, for why further environmental advantages can be achieved. A comparative analysis of those materials with consistent stiffness properties showed, that the new material saves 30% in CED as well as 35% in CF.

Process: Specific energy demand

Changes in the material composition entail adaptations in the manufacturing process, such as the injection molding process. To begin with in the laboratory, the energy demand of the injection molding process was analysed for different molding compounds with a matrix of PP and different shares of fossil and bio-based fillers. Thereby, the impact of different filling materials and their share in the composite on
the process of injection molding, hence on the specific energy demand of the process, could be identified.

Following the analysis of the power curves, the cycle times and process phases were determined. The shot weight was used to calculate the specific energy demand [MJ/kg]. The results span a range between 1.7 MJ/kg and 3.2 MJ/kg, whereas the bio-based fibre composites are found in the lower section of the range. It was shown that this is achieved by a shortened holding phase, which is especially energy intensive.

**Upscaling: Specific energy demand**

In addition, three molding compounds were processed on two industrial-scale machines in order to assess the impact of upscaling. Considering the upscaling of shot weight and the resulting necessity to switch to bigger machines, it was shown in three experimental series that the specific energy demand indicated both an increase as well as a decrease in efficiency. On the one hand, savings in cycle time accounted for about 40% of process energy. On the other hand, the switching of technology from all-electric to hydraulic machines resulted in a higher demand of operating power.

**Impact and effects**

Bio-based fibre composites can be an interesting alternative towards bio-economy: by substituting fossil-based material with renewable material, by saving resources through increased functionality, as well as by saving energy through adapted processing.

In this study, the influence of composite recipe and upscaling of a new bio-based fibre composite on the environmental performance was subject to research in order to provide feedback for further research and development.

It was shown that a differentiated environmental assessment during the process of material development can provide important input.

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**Contact and information**

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