Reducing the CO_2 Footprint

Determining CO_2 Savings from Recycled Materials and Bioplastics

The plastics industry has a variety of materials and technologies available for significantly reducing the ecological footprint of products. There are very few applications for which it is not possible to replace at least a portion of the fossil material with recyclates or bioplastics. Various methods, standards and software tools are available to determine what savings this can achieve.

Political signals and consumers' wishes are leading the way: the increasing consumption of scarce raw materials resources should be reduced and the negative impact of production, as well as unnecessary use and incorrect disposal of plastics, should be minimized. At the top of the agenda is the reduction of high CO_2 emissions and marine pollution.

The European Commission's Green Deal envisages the circular economy for plastics playing a key role. It is forecast that, by 2022, minimum quotas will be imposed for the use of recycled materials in new products. [1] By 2030, virtually all plastic packaging will be reusable or recyclable. The Zero Pollution Action Plan presented by the European Commission in May 2021 specifies further targets, such as a 50% reduction of plastic and other wastes in the oceans by 2030. Consumers are also increasing their requirements: when purchasing, many are increasingly paying attention to how sustainably a product has been manufactured. The industry must respond to this by making modifications to production processes. Many companies have already committed themselves to the target of climate neutrality in order to support the guideline given in the Green Deal of global greenhouse gas neutrality by 2050.

To achieve this goal, it is also crucial to boost the recycling infrastructure for plastic waste. In particular, the collection and separation take center stage. The

Fig. 1. Hinge arm for the tank cap of Audi vehicles: by switching to a PP with recycled carbon fibers, the weight could be reduced by 32 % and the CO_2 emissions by almost 75 % © Albis

potential for environmental protection and sustainability is great: cradle-to-gate life cycle assessments performed by polymer manufacturers and compounders have resulted in considerable CO_2 savings. The precise quantification depends on the type of polymer and the recycling technology used in each case. Savings of significantly above 50 % have already been published.

What Materials Are Available?

In this context, it is very important for companies to look at exactly which sustainable materials are suitable for their applications. This requires an exact analysis in order to choose the best product as a replacement for virgin material. For this purpose, the distributor Albis offers a variety of solutions based on differing technologies and raw materials, and has examined in various studies what CO_2 savings can be achieved in this way.

In terms of quantity, recycled materials currently play a major role. The product's quality and properties depend on the particular recycling technology employed. Products made from recycled materials originating from the production of industrial applications, known as post-industrial recycling or PIR, often achieve a quality level almost matching that of virgin material. But plastics from post-consumer recycling (PCR), too, now have a consistency and quality that allows them to replace virgin material.

Another option is to use plastics from renewable and bio-based raw materials. They provide product properties identical to those based on fossil raw materials, but with lower CO_2 emissions. At the same time they reduce dependency on dwindling fossil raw materials. However, one hundred percent bioplastics still remain a long way from mass production.

The choice of the most suitable material for the particular application is determined not least by the specific regulatory requirements of the particular industry, for example medicine, the foods sector or electrical and electronics equipment. There are many applications for sustainable materials in the automotive industry, where numerous plastic components are made from these materials.

Great Interest in Bioplastics in Medicine

In medical applications, there is a strong interest in employing more sustainable plastics, bio-based where possible. The same applies to the cosmetics industry. Here, PCR and PIR materials are state of the art for all parts that do not come into contact with the contents. If, on the other hand, there is contact with the contents, bio-based variants are currently particularly suitable. In addition, the first products combining PET recycled materials (polyethylene terephthalate) with bio-based raw materials are available for the cosmetics sector. For technical parts from the electrical and electronics industry, which require flame retardancy, more sustainable materials containing a recycled proportion are already available.

Irrespective of what the industry is: to reduce the CO_2 footprint of a product, it is worthwhile looking at the details, since even small-scale applications make a contribution to greater sustainability. Each recycled unit is an important step.

Methods for Determining the CO_2 Savings

Plastic recycling can thus make a positive contribution to the life cycle assessment (LCA) of a product. To make a qualitative estimate of the chosen process, however, it is necessary to quantify exactly how high the specific CO_2 savings for a product actually are. For this, various methods, standards and certificates are used.

For product-related life cycle assessments, for example, the ISO standards series 14040 can serve as basis. The three-part ISO 14064 regulates the determination and inventorying of greenhouse gas emissions for reporting and verification. The ISCC certification system (International Sustainability & Carbon Certification) for circular and bio-based approaches has already been in use for many years.

Calculating the Life Cycle Assessment of Products with GaBi

A software tool that is used by, among others, some automotive manufacturers is the GaBi life cycle assessment software from the manufacturer Sphera Solutions. Mocom and Wipag, which are part of the Otto Krahn Group, also use GaBi to calculate the CO_2 demands of their products in order to make their products and processes even more sustainable. The data for the calculation are obtained either from the extensive software database or from own measurements. With the tool, specialists have precisely analyzed and modeled the material and energy flows of the carbon-fiber recycling processes at Wipag in order to increase the accuracy of the LCA of recyclate-based compounds, even when individual process steps are used.

Product Examples Show the Level of CO_2 Savings

The savings that are possible using such sustainable materials are shown by some three projects by Albis together with partners. The so-called WIC compounds developed by Wipag, based on recycled carbon fibers, are successfully used in the automotive industry, for example. They support lightweight design »

Fig. 2. The stand for the mobile beach volleyball net is made of 100 % recycled material from post-consumer wastes © Decathlon

concepts while simultaneously saving CO_2. The high strength and stiffness of the material allows relatively heavy high glass fiber-reinforced polyamides (PA) to be replaced by more lightweight carbon fiber-reinforced polypropylene (PP). An established product is, for example, the tank-cap hinge arm for vehicles from Audi (**Fig. 1**). In this case, instead of PA66-GF50, the compound WIC PP 30 (PP with 30 % carbon fiber-reinforcement) is used. Besides a weight saving of 32 %, the CO_2 footprint has been significantly reduced thereby. Calculations carried out using the GaBi software showed that the WIC PP 30 only comes in at 1.26 kg CO_2e/kg, while standard PA is at 5 kg CO_2e/kg.

Ever more consumers are also paying attention to sustainability when purchasing sports and leisure products. Together with the French sports article manufacturer Decathlon, Albis has therefore realized a stand for a mobile beach volleyball net made of 100 % recycled material (**Fig. 2**). CirculenRecover polymers from LyondellBasell, which are made of PCR, are used here and offer a good price-performance ratio. One aim of the project was that the net stands can be repeatedly recycled. Due to the use of recycled material, the CO_2 emissions of the sports article can be considerably reduced – with uniform quality and while maintaining toxicity requirements. A study performed by the compounder QCP with LyondellBasell's Moplen and Hostalen grades had the result that CirculenRecover polymers permit a reduction of CO_2 of up to 70 % compared to virgin material.

PA6 from PIR Reduces CO_2 Emissions Significantly

Another example of a challenging application of recycled plastics is the use of Altech PA6 Eco for a snowboard binding. It is manufactured by CTM-System Metall- und Kunststofftechnik by injection molding. The PA6 consists of PIR, which reduces the CO_2 emissions from 5.7 kg CO_2e/kg (fossil-based PA6) to 0.72 kg CO_2e/kg. The calculations were carried out using the GaBi software. The material achieves the properties necessary for the high loads on the binding, such as the required cold impact strength and surface texture.

Recycling and the circular economy will play a central role among plastics manufacturers and processors in the coming years. For the companies, that also means checking exactly which materials are suitable for the particular application. This requires knowledge about the methods for calculating CO_2 savings. For Albis, products based on recyclates or renewable raw materials hold a key position in the product portfolio and their share is growing steadily. Together with customers, sustainable, requirement-specific applications will be increasingly developed with the goal of reducing CO_2 emissions ever further. The company makes use of various methods for determining the life cycle of products. ■

Fig. 3. The snowboard binding from CTM-System is made of PIR. This ensures a lower CO_2 footprint © Jones Snowboards

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Service

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