The New Carbon Blacks Are Green

Sustainable Carbon Black via Pyrolysis of Used Tires

Increasing demands on material performance in the polymers industry compete with the need for sustainable high performance materials and additives. As businesses recognize the importance of lowering their carbon-footprint, raw materials that help them achieve this goal are growing in demand. The polymers additive, carbon black, can now be gained from post-consumer tires by means of a new recycling process.

Production of recovered carbon black at the cct plant. The material from used tires comes roughly shredded and is conveyed to the pyrolysis reactors (© cct)

For many years compounds have been made more environmentally friendly through the use of recycled polymers. However, the used additives, excipients or fillers such as oil-based pigments can limit the sustainability of a product. A new additive, a carbon black type product from post-consumer tires, offers an alternative. This additive of the manufacturer cct Stegelitz GmbH, Stegelitz, Germany, is called recovered carbon black (rCB). It is used as a pigment in plastic manufacturing or in the production of rubber compounds for technical rubber goods and tires. rCB has proven to be a very promising material [1] for establishing a sustainable plastics industry. Not only can it be used as an additive in polymer compounds, but also in masterbatch thermoset powders or coatings. Further, in comparison to traditional carbon black, which is produced from the combustion of oil and gas, rCB also has a significant price advantage.

Production of Recyclates

Post-consumer tires are tires which are no longer suitable for their original intended purpose or whose rubber material has become brittle over time. This rubber, however, contains valuable raw materials such as carbon black, which can be recovered for reuse in other applications. The recycling of used rubber does not deplete resources, such as heavy oil fractions used for the production of traditional carbon black. In addition, the production method emits less CO_2 and closes the material cycle of the tire and technical rubber industries. Calculations have shown that with each full truckload of rCB (i. e. 22 t of material) customers save approximately 68 t of crude oil and avoid emissions of 57 t of CO_2 [2] compared to traditional carbon black.

The feedstock used for the production of rCB is coarsely shredded post-consumer rubber, mainly from passenger car tires. This allows good quality control since the individual components of the tire are still clearly visible. During each delivery of tire shreds, a physical inspection takes place to access the overall quality of the material. The shreds are loaded onto a conveyor belt and transported to the pyrolysis reactor. In the reactor, in the absence of oxygen and at a temperature of 500 °C, the tire shreds thermally combust. During pyrolysis the organic components of the tire shreds decompose and vaporize allowing the process oil from the rubber to be siphoned off and resold for fuel. The remaining solid components are further processed. With a magnet, the steel is separated out for resale, and the remaining solid material is further processed into rCB. The final rCB product is pelletized similar to the packaging of conventional carbon black.

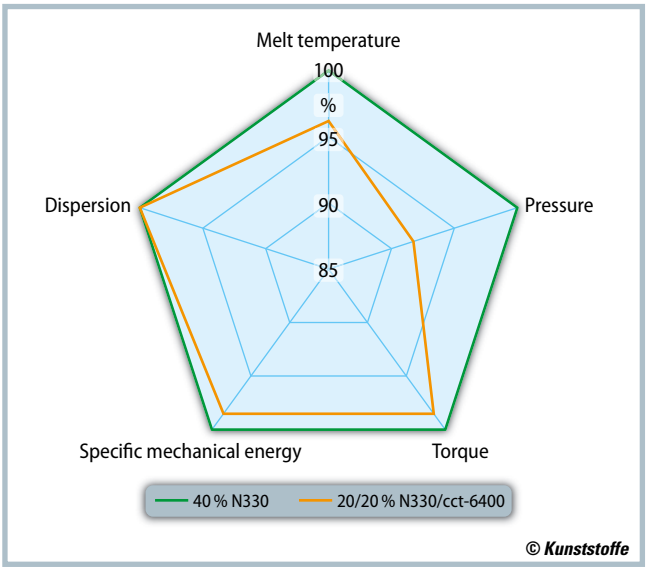

Fig. 1. Net-diagram comparing the characteristics between masterbatches containing 40 % carbon black. The variation N330/cct-6400 is comprised of 50 % recovered carbon black, whereas the other variation is 100 % traditional carbon black (source: cct)

rCB grades for different applications can be produced by carefully combining varying input material (e.g. passenger car tires and truck tires). Each new grade of rCB is produced afterwards from the same type of pre-evaluated and tested feedstock. In addition to tires, the research and development team of cct is also investigating other raw materials such as conveyor belts or profiles to develop further rCB types that meet the needs of customer applications. Product quality and reliability are also established through external audits. As the first European industrial manufacturer of rCB, cct received certification of its quality management system according to ISO 9001 and its environmental management system according to ISO 14001 standards.

Use in the Polymer Industry

Due to the wide range of polymer applications that use carbon black, cct offers its customers a comprehensive service. Although the long-term goal is 100 % substitution of traditional carbon black, focusing on partial substitution provides rCB manufacturers and compounders fast and cheap usability. Appropriate testing phases are conducted with the customer to determine the appropriate balance of product properties and compound returns.

rCB has been successfully incorporated into masterbatches of polyethylene (PE) or polypropylene (PP) and in amino-based thermoset powders. For this usage rCB is suitable as compensation of carbon black because of its lower conductivity, similar color strength, low levels of polycyclic aromatic hydrocarbons (PAHs) and it shows a reduced specific energy for a similar dispersion.

Application in a PP Masterbatch

A German plastic compoundeur is producing a polypropelene masterbatch with N330 carbon black. To evaluate rCB's suitability in such an application the performance of a 40 % weight masterbatch produced with a 50 % rCB/N330 blend (N330/cct-6400) and of a 100 % N330 reference is compared. This was compounded using a twin screw extruder at 10 kg/h at 660 rpm, and further let down to 1 wt. % to test dispersion and color properties.

The evaluation indicated that to achieve an equivalent dispersion to the reference compound, less energy was required per kg (**Fig. 1**). In addition, color testing show a similar jetness and undertone for both the N330 reference and the cct-6400 blend (**Table 1**). The masterbatch is also very evenly dispersed. A masterbatch producer can benefit from significant savings in raw materials and mixing energy through the substitution of 50 % of the carbon black through rCB. A sample calculation shows that approximately 388 t of CO_2 and 463 t of oil can be saved by a masterbatch producer who instead of using 300 t traditional carbon black per year, substitutes 50 % with rCB. These environmental advantages, paired with almost 20 % cost savings over traditional carbon black, set the stage for a more sustainable polymers industry. ■

	L* Color depth	a* Green/magenta	b* Blue/yellow
N330	12.07	0.19	0.81
N330/cct-6400	12.46	0.14	0.56

Table 1. Color comparison of injection molded PP masterbatch samples within a Cielab color space according to EN ISO 11664-4 (2 mm diameter / 1 wt. %) (© cct)

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Company Profile

cct Stegelitz GmbH (carbon clean tech – cct), founded in 2007, is the first industrial producer of rCB in Europe. cct opened its first commercial production facility in Stegelitz near Magdeburg, Germany, and has a current capacity of 4000 t rCB per year. After the recent merger with Pyrolyx AG, Munich, Germany, the company has planned to further expand production capacities. cct is an active member of the ASTM standards committee for carbon black and working towards the standardization of rCB in the polymers industry.

- www.carbon-clean-tech.com
- www.pyrolyx.com

Service

References & Digital Version

- You can find the list of references and a PDF file of the article at *www.kunststoffe-international.com/1276746*

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