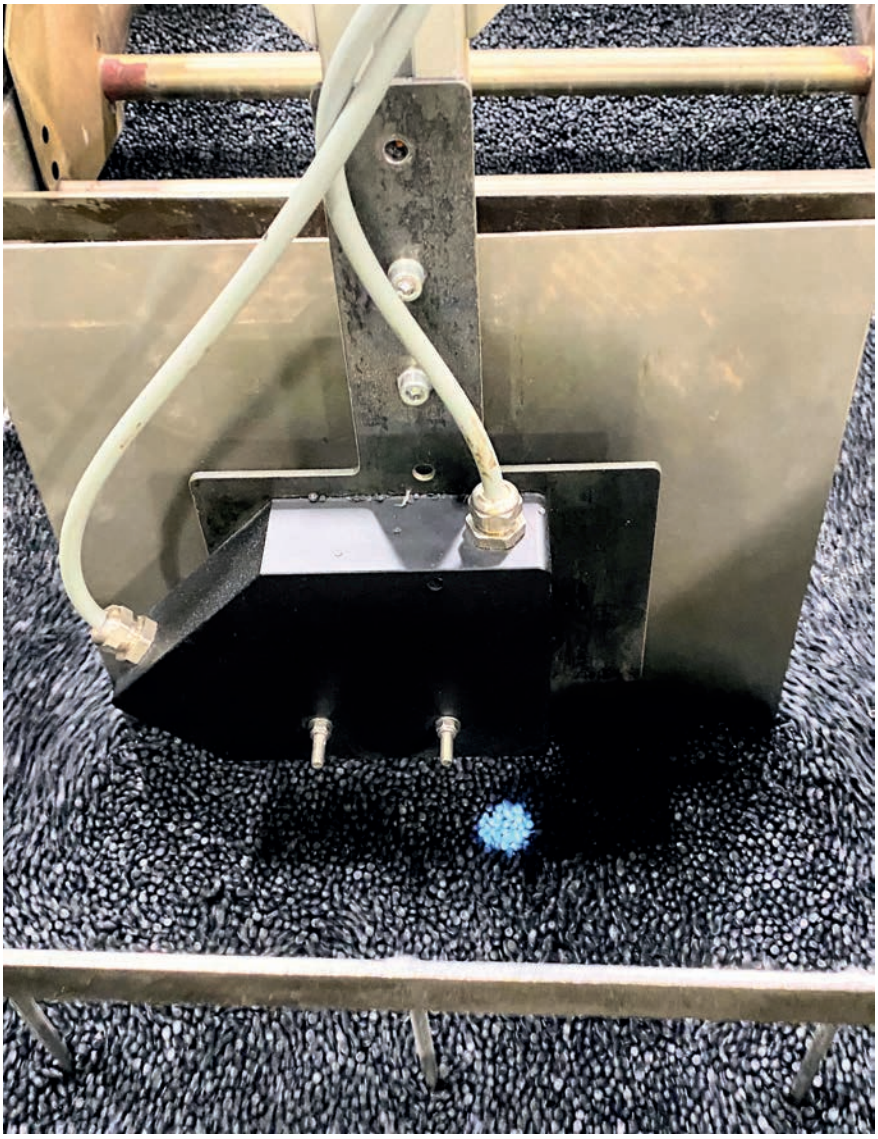
Ensuring Constant Recyclate Color Values through Inline Measurement

Automatically Adjusting to the Desired Color

Because of their intrinsic color, recyclates are often more difficult to color than virgin material. For adjusting to the desired color, various methods are available. Inline color measurement plays an important role here. An industrial project now shows that promising results can be obtained by color measurement of the recyclates on the vibratory conveyor immediately after pelletizing.



Color sensor front end, including the device for height adjustment of the product stream, immediately after pelletization and the drying process of the recyclate: The 20 mm-sized measurement spot compensates for the random position of the pellets and the vibration of the vibratory conveyor, and thereby ensures high measurement accuracy. © Sensor Instruments

The European Union wants to reduce the amount of packaging waste and promote a sustainable circular economy for packaging. That is why it passed the Packaging and Packaging Waste Regulation (PPWR). Because of such regulations and the desire of many consumers for sustainable products, the plastics processing industry is turning more and more to recycled materials, which increasingly undergo so-called "upcycling." In this procedure, the plastic wastes are processed into recycle, which is subsequently used to produce high-quality materials.

The color of the recyclate is one of the important quality characteristics in this. Plastics processors strive for uniform quality of the manufactured products also when using recycled materials. After all, consumers are unlikely to show much understanding for fluctuations in the product colors. The color must therefore be kept constant even when recyclates are used. To implement this, it is advisable to use a fully automated color control system. The measurement technology manufacturer Sensor Instruments is currently working together with the plastics recycler PreZero Polymers on the implementation of automated inline color measurement and control for recyclates.

To achieve the aim of fully automatic color constancy, a control loop is necessary. The actuator plays an important role in this. To obtain the desired recyclate color, pigments or dyes must be added. Feeding of the respective

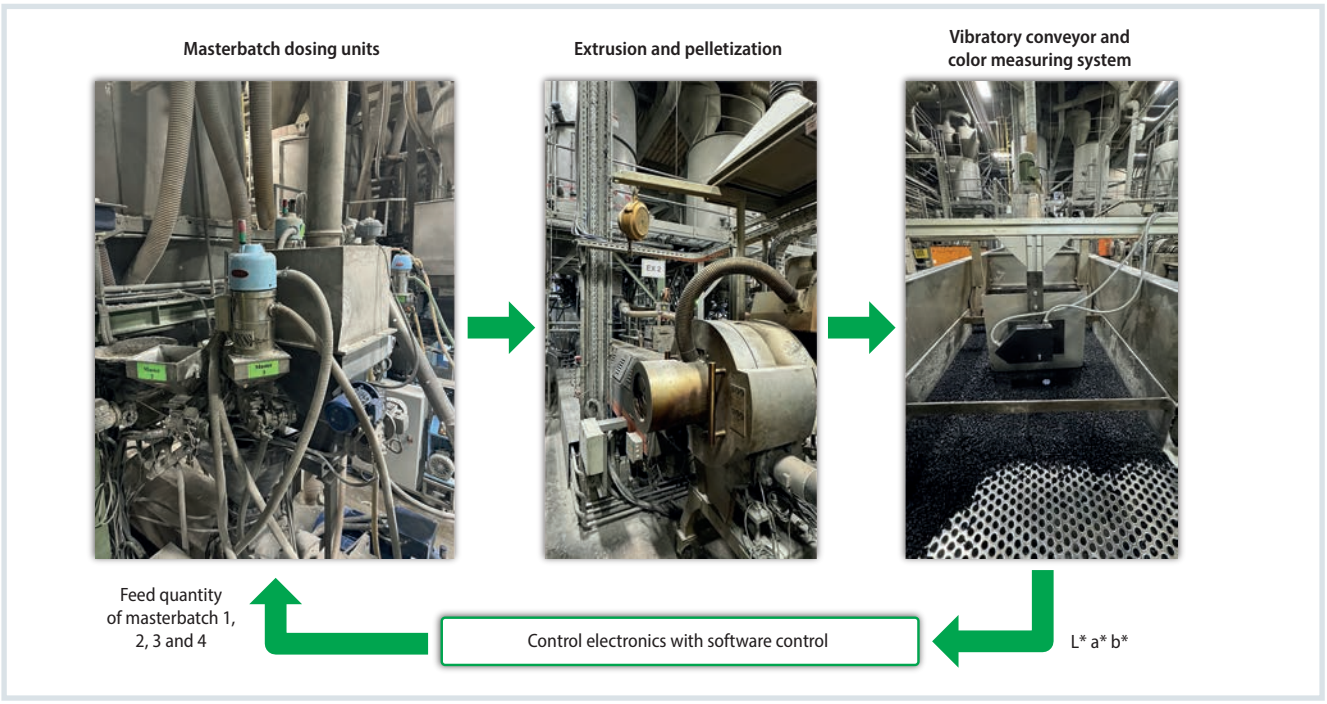


Fig. 1. Control process for color stabilization of the recyclate: The dosing unit (left) feeds masterbatch to the recyclate in the extruder and pelletization (center). The color measurement mounted on the vibratory conveyor (right) subsequently analyzes the color of the pellets and transmits the values to the control software. This can then automatically adjust the masterbatch feed. © Sensor Instruments

colorant can now be carried out by means of a liquid colorant dosing system or a masterbatch dosing unit. Until now, masterbatches were used in operation for manually controlled adjustment of the recyclate color value. Thus, the findings for the colorant additives, which were previously empirically determined, can now be applied to the particular desired recyclate product. Masterbatch dosing systems can therefore also be used for automatically controlled color adjustment.

Four Dosing Units for Uniform Color

Usually, up to four dosing units are used. A masterbatch determines the basic color, providing a recyclate color shade whose $L_{basic\ color}$*, $a_{basic\ color}$* and $b_{basic\ color}$* values are in each case slightly below the desired target color values $L_{target\ color}$*, $a_{target\ color}$* and $b_{target\ color}$*. A white masterbatch can now primarily increase the L* value, a red masterbatch, principally the a* value and a yellow masterbatch predominantly raises the b* value, so that the recyclate takes on the color value within the control time. Alternatively, a basic color can be chosen whose color triplet is slightly above the target color triplet to be achieved. Instead of white, black (L*) is then used, green (a*) instead of red, and blue (b*) instead of yellow.

A Large Measurement Spot Ensures High Accuracy

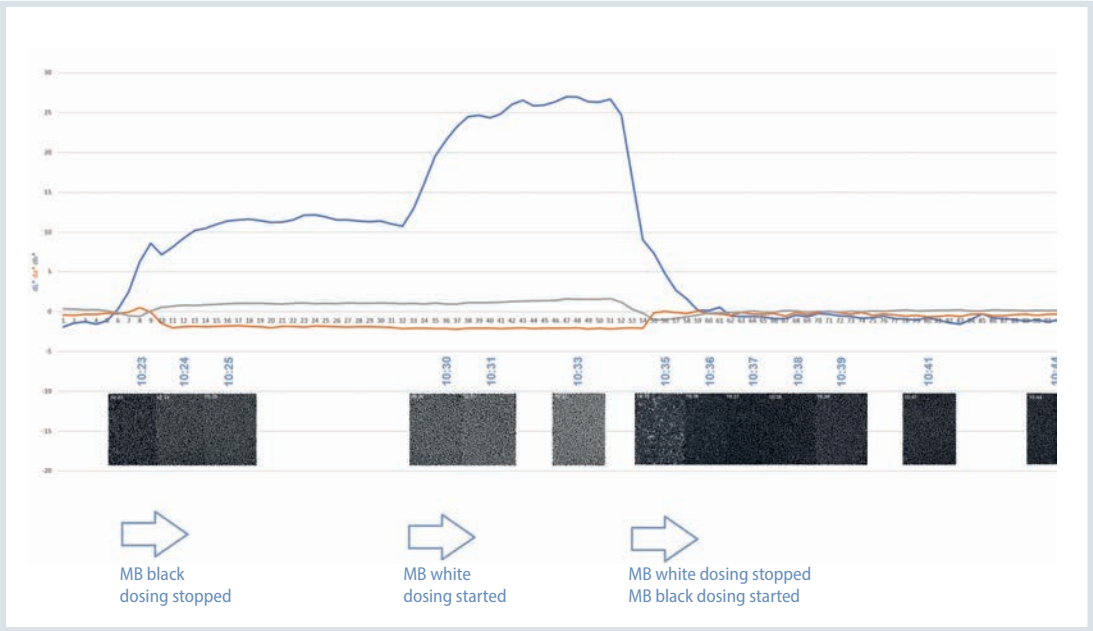
To be able to better compare the color measurement results of the recyclate types produced hitherto with the results from the inline color measurement, the color is determined from the recyclate and not in the melt. As a suitable measurement location, a region on the vibratory conveyor, after pelletization, was chosen (**Fig. 1**). The measurement is carried out with the Spectro-3-FIO-MSM-ANA-DL color sensor and the corresponding KL-D-0°/45°-1200-A3.0 measurement head from Sensor Instruments.

This is arranged at a distance of 85 mm from the recyclate surface. The approximately 20 mm-wide circular light spot is directed perpendicular to the recyclate stream, while the receiving optics registers the recyclate surface at an angle of 45°. The height of the recyclate stream is kept constant at 85 mm from the sensor front end by means of an aluminum plate. The ideal measurement time of 15s was empirically determined. At a recyclate flow rate of 100 mm/s, a product length of 1500 mm is recorded to form the mean value. As a result of the 20 mm-diameter light spot, the pellet area on which a color value is determined is 1500 mm x 20 mm. The random position of the pellets and also the vibrations of the conveyor are almost completely compensated, resulting in a measurement accuracy of typically dE = 0.3.

Notifying Plant Operators about Color Values and Deviations

In the following example, a black-pigmented recyclate was started and the feed of black masterbatch was subsequently stopped. Two minutes later, the color of the starting material could be measured. In the next step, white masterbatch was added. After a period of about 3 min., an almost uniform color value could be measured (**Fig. 2**). By stopping the feed of white masterbatch and repeated dosing of black masterbatch, the initial state could be restored. In a further experiment, after the feed of black masterbatch was stopped, blue masterbatch was added in various dosage steps. Here, too, the results were positive.

The color values are not only made available via the serial interface, but »



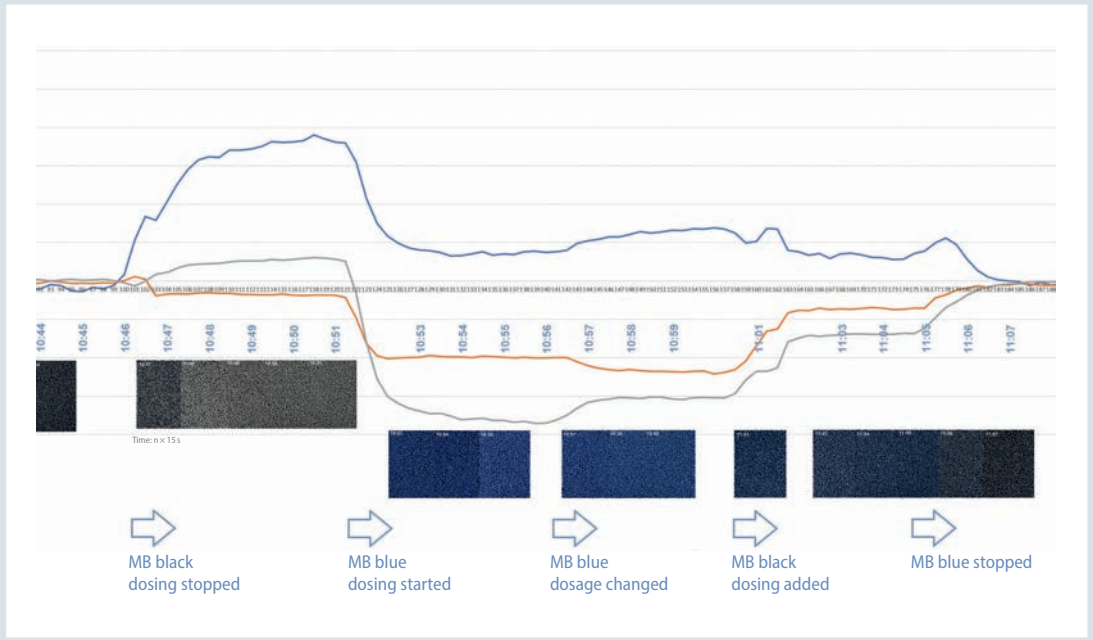


Fig. 2. With the example of a black recyclate, it can be readily seen how the color is changed by the added masterbatch (MB, white at the top, blue at the bottom). In both cases, a uniform coloration was established after a short time.

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also the plant operator is informed about the current color values, their deviation from the setpoint value and the trend. This information allows the operator to adjust the volume at the dosing device.

Long-term tests are still underway on the system with a corresponding range of recyclates. The aim remains to close or automate the control loop. Work is already underway on the software controller and connecting the dosing units to the external actuation, so that a controller can be switched over to a controller in the medium term.

Summary

By continuous inline recyclate color measurement on the vibratory conveyor, the color values can be recorded with an accuracy of up to dE = 0.3. In addition, corresponding masterbatches are added to the target color in a proportion of up to 2 % of the total material feed. Besides recording the measured values, the plant operator is provided with the current color value L*, a* and b* in numerical form and the color value deviations dL*, da*, db* and dE for the respective reference in numerical form and as a graph. ■

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Service

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