The road to a circular packaging industry

Edmund Tenfelde,
Bollegraaf CEO

Pargner Content
Bollegraaf

A circular economy by 2050. It's a great ambition, but a lot still needs to be done to transition from a linear economy to a circular economy. In a circular economy, raw materials are used in the most optimal fashion. However, a circular economy is not possible without recycling and advanced separation technology.

Attention to the recycling of plastic continues to grow now that China has prohibited plastic waste streams from entering the country. In the coming years, plastic will receive increasingly more attention. In fact, it is a dire necessity. Making plastic packaging into a circular resource is one of the major environmental challenges of our century. This is particularly true for higher quality recycling. Indeed, obtaining a high-quality recyclate is a huge challenge.

This growing recognition is stimulating action around the world. According to a recent study by the Ellen MacArthur Foundation, the use of plastic will double in the next twenty years and quadruple by 2050. In 2024, at least 70 percent of the single-use plastic in the Netherlands that will end up in garbage bins will be recycled without deteriorating in quality. In 2025, all single-use plastic products will consist of 35 percent recycled plastic.

The packaging industry, in particular, is looking for a Closed-Loop methodology where we will deal with plastic packaging materials in a completely circular manner. "Currently, about 78 million tons of plastic is produced in Europe, but only 14% of it is collected for recycling. And, only 2% of all plastic in the industry is actually recycled in closed-loop recycling," said Edmund Tenfelde, CEO of Bollegraaf Recycling Solutions. "And this happens even though 359 million tons of plastic is produced. This means we still need to take huge strides forward."

Improved recycling

Awareness is growing quickly around the world that we must change our lifestyle. In the last 3 years, Bollegraaf's strategic priorities anticipated the evolution of the recycling sector. These are and continue to focus on the increasing complexity of the requirements of the recycling industry, the increasing demand for new advanced separation technologies, and modular-built automatic sorting systems with operational flexibility to be able to flexibly handle future changes.

> *The market demands the highest quality recyclate, preferably the same quality as virgin-grade plastic made from primary raw materials. That's our job!*

The R&D manager of Bollegraaf said that at the moment recycling is primarily focused on mechanical recycling. In past years, a lot of plastic was converted into garden benches and roadside posts in different shades of gray and beige. Of course, this is a good thing. However, the market is now becoming saturated and you can't really call it upcycling (a form of recycling where the product is processed into one or more new high-quality products). If we really want to change this, we need to find a different solution. There is increasingly more pressure from governments and the public to recycle and achieve ambitious target volumes. To do so, the market requires the highest quality recyclate, preferably the same quality as virgin-grade plastic made from primary raw materials. That's our job!"

Amongst other methods, Bollegraaf believes the solution is new advanced separation technologies to achieve higher-quality mechanical recycling and a higher quality of recyclate in combination with chemical recycling. "We are well known as innovators that focus heavily on new technologies," said Tenfelde. "This is how we bundle our strengths in Europe and the USA with other corporations in the industry."

In 2018, Bollegraaf used its knowledge and experience to design and build a recycling system for a renowned USA customer to demonstrate the recycling of flexible plastic packaging and its technical and economic feasibility. This involved the recycling of all flexible plastic packaging from (household) single-stream waste streams. This was part of the scope of a research program that was a pilot to test the recycling of flexible plastic packaging. The research was carried out by the institute for Materials Recovery of the Future (MRFF), which is the American counterpart of the Plastic Pact presented in the Netherlands in 2019.

Bollegraaf's knowledge and advanced separation technologies for systems sorting flexible plastic packaging recently won it a tender in the Netherlands. They can now commence building the new National Plastics Test Center (NTCP).The NTCP is an independent test and development center that focuses on the circular recycling of plastics.

Besides developing new sorting systems and separation technologies for the recycling of various types of plastic packaging, Bollegraaf invests in new technologies that mechanically process non-recyclable plastic into fuels or – preferably – chemical raw materials to be used to produce new plastics. Tenfelde sees the rise of (thermo-) chemical and physical recycling or dissolution as a development – together with an optimized mechanical route – needed to increase the percentage of reused waste plastics and, thus, the value optimization in the chain, to the desired level.

Here too, the optimal sorting of waste into the highest quality possible is of the utmost importance. (Thermo-) chemical recycling processes, such as pyrolysis, produce pyrolysis oil, an alternative to naphtha. This pyrolysis oil is delivered to the base chemicals sector as fuel for cracker facilities, which then provides the raw materials needed to produce new plastics. These plants cost billions. So, it's of the utmost importance that the fuel is of a high quality and dependable. And the quality is determined to a large extent by the quality and purity of the plastic.

For example, UV light will discolor or deteriorate the quality of the plastic. You can use physical recycling or dissolution to separate additives, such as dyes or flame retardants, from the polymers. You can also, for example, separate different polymers.

The purified streams from such a process can, in turn, serve as a raw material for new products. This process also requires an extremely pure, well-sorted, plastic stream. Bollegraaf is also working hard on this process. For example, UV light will discolor or deteriorate the quality of the plastic. Currently, no one has been able to match the original color of the plastic, e.g. Lego blocks. However, in part due to better sorting, this sort of dissolution technology will make it possible in the future. This is still a bit premature, but it's where we eventually want to be. In fact, universities, research institutes, and industry are working hard on this process. We want to be at the forefront of eventually achieving 100% recycled materials that are possibly even better than it previously was."

In 2018, Bollegraaf built a sorting system for SUEZ and Kempenaars waste management services to sort different types of hard plastic and foils for recycling. It's a one of a kind in terms of applied technologies and high-quality recycling. The company was able to double its yield by using a higher quality recyclate with a purity above 95%. This makes it the only company in Europe that processes plastic in this manner. SUEZ and Kempenaars operate under the name SK Polymers BV. This joint venture is working on smart solutions to make hard plastics suitable for recycling. They will be able to process used (hard) plastics to supply high-quality raw materials to the plastics manufacturing industry.

Moreover, some types of chemical recycling make it possible to recycle more recyclate for use in food packaging. "Currently, no one can. But we're striving to make plastics fully recyclable and restore it to its original quality and properties. For example, take the plastic Lego brick. This type of brick washes out and becomes less yellow over the years. Currently, no one is able to restore the original yellow color. But chemical recycling will make this possible in the future. This will allow you, for example, to restore the carbon compound and thus restore the true color and quality. This is still a bit premature, but it's where we eventually want to be. 100% recycled materials that are possibly even better than it previously was."

Artificial intelligence (artificial intelligence, AI) and Robotics

Bollegraaf is also fully committed to new technologies, such as artificial intelligence and robotics. Sorting waste is hazardous work that may cause injuries and accidents. Thanks to recent developments in artificial intelligence, waste sorting robots are increasingly being used in recycling plants. Cameras and advanced machine learning algorithms allow these robots to recognize specific objects in a pile of waste, such as plastic, glass, or other recyclable material, in seconds.

"The latest development is a sorting robot with a maximum capacity of ninety picks per minute. The intention is to replace quality control that is performed manually. This not only exceeds what a worker can do per minute, but also contributes to safety and health in the workplace," said Tenfelde. This robot is called the RoBB-AQC. It's the smartest, most precise, and most reliable sorting robot on the market. "The robot can recognize and sort plastics that can't be recognized using conventional technology. We're working really hard on these technologies so we can achieve our closed-loops objectives in the future, supply high-quality recycled raw materials to our customers, and supply raw materials to the plastic producing industry."

In 2005, Bollegraaf introduced the first sorting robot for quality control. Since then, we have developed different types of robots. The current RoBB-AQC is a fully automated sorting robot. The new leading-edge RoBB-AQC sorting robot from Bollegraaf can be configured with a Near-Infra Red machine vision system supported by artificial intelligence (AI) that makes it possible to accurately sort all recyclable materials and plastics.

The artificial intelligence even allows the RoBB-AQC robot to learn how it must identify new types of materials and then start the learning process. The learning feature offers our customers a lot of flexibility.

The recycling industry has to deal with the continuous change in legislation and the value of recycled materials. Bollegraaf's sorting solutions can be adjusted accordingly, explained Tenfelde. Moreover, the RoBB-AQC robot has a laser system that can estimate the height of the product to be sorted. The Near-Infra Red machine vision system supported with artificial intelligence allows the RoBB-AQC robot to increase the quality of the recycled plastic and remove contaminated items. This allows our customers to sort much better than ever before and achieve high-quality recycling and a higher-quality recyclate. This results in a higher yield of a recyclate that is higher in quality and purity. Moreover, once a RoBB is installed, it's also hugely flexible. The manner in which it is designed makes it easy to install in current sorting lines. And this is true even when conditions are not optimal. "We already have a RoBB installed in a test center on an uneven surface, which means it has to operate against gravity. Nevertheless, it works exactly as it should."

Closed-Loop Plastics Recycling

Ever since the Industrial Revolution, we have relied on natural resources to maintain the rise in our standard of living. Increasing scarcity means we must now look to more sustainable systems. There are two types of recycling: an open system and a closed system. Closed systems recycle glass, steel, and aluminum. These materials can be recycled repeatedly and retain the same quality. This is the definition of closed-loop recycling.

With open-loop recycling or downcycling, the quality of the material decreases each time it is recycled. Good examples are paper and plastic. Another definition of open-loop recycling is where recycled material is used in another value chain (it can also be of a very high quality – and that by definition is not downcycling). That's not what we mean here. Recycling this type of material becomes less interesting over time. Closed-loop recycling of plastic will eventually make it possible to go from food-grade to food-grade recycling. In closed-loop recycling, the material is reused for a similar application. To make this possible, the recycling industry requires sorting plants to separate waste fractions to a high level of purity to satisfy their customers' demand for high-quality recycled end products so they compete against new materials in the market.

> *With open-loop recycling or downcycling, the quality of the material decreases every time it is recycled*

This trend in the recycling sector also boosts the demand for more specialization and knowledge of advanced sorting processes and the ability to flexibly sort different types of plastic with a high level of purity. Bollegraaf anticipated this trend and in the meantime has completed different projects that handle these new needs, such as the first sorting plants of their kind in the world that specialize in plastic film: the plastic sorting plant for Daly Plastics in Zutphen. The expertise in both companies produced an innovative, modular, and fully automated recycling plant.

It's the most efficient, professional industrial plastic sorting plant of its kind in the Netherlands. The installed plant at Daly Plastics in Zutphen separates 7 tons of plastics by color, including HDPE, PP, and LDPE. This allows the company to produce a very pure regranulate as a raw material for high-quality new products.

Another plastic project that Bollegraaf completed is the plastic recycling plant for Morssinkhof Rymoplast at the Haskerveen business park in Heerenveen.Morssinkhof Rymoplast will process plastic separated by the sorting plant into high-quality secondary raw materials. Besides the plastic packaging waste from the sorting plant, the factory will process similar waste streams from the Netherlands and neighboring countries. The ultramodern factory can process PP and HDPE plastics from consumer waste into secondary raw materials for high-quality applications. This plant demonstrates that Bollegraaf is at the forefront of innovation in the development, engineering, and production of turnkey recycling solutions that produce very pure regranulates as raw materials for high-quality new products.

Bollegraaf is active worldwide. Last month, it delivered the largest factory for plastic recycling ever built in England. "In our sector, specialization in modular-built automatic sorting systems with operational flexibility and the development of new advanced separation technologies is the key to success in the coming years," Tenfelde explained.

Bollegraaf now has different technologies that produce the highest achievable purity in plastic recycling, which is one of the requirements for closed-loop recycling. The circular economy is an alternative, more sustainable model compared to the traditional linear economy. In a circular economy, we continue to use raw materials and products as long as possible. As a market leader, Bollegraaf wants to contribute to this in its sector by converting non-recyclable plastics into oil or recycled plastic into very pure regranulate as raw material for high-quality new products. "We are quite ahead of the game and at the forefront with these developments in Europe and the USA where we have been active for 39 years. We also have a large market share there," said Tenfelde.

Bollegraaf in the past 59 years has proven itself to be the market leader in the sector. Relatively speaking, it invests quite a lot in research into and the development of innovative technologies for closed-loop recycling.

Bollegraaf stays current to ensure it can innovate throughout the entire life cycle of plastics and provide a significant contribution to the implement a circular economy. It also has its own test centers and has installed more sorting plants globally than all of its competitors put together. "And, of course, it's a real kick that such a company is from the Netherlands." Bollegraaf Recycling Solutions is now a mature complete-solution provider for the circular economy and the recycling of waste streams into valuable raw materials. And that redounds to Dutch workmanship.