Assuring the quality and safety of recycled plastics

Empowering Trust®

To address growing concerns about quality, safety and environmental attributes of recycled plastics, many manufacturers are now seeking evidence from suppliers of not only the percent of recycled plastic content in source material, but in the performance attributes and quality of that source material.

As the world becomes more attuned to the environmental impact associated with plastic waste, more manufacturers, producers and retailers are actively exploring ways to reduce their dependence on virgin plastics and to increase their use of recycled plastic materials.

At the same time, however, the quality of recycled plastic materials varies greatly from recycler to recycler. Methods for communicating the quality of recycled or reused plastic materials are not standardized, and extended supply chains complicate the process of ensuring consistent quality in the composition and production of recycled plastics. Further, as demand for recycled plastic material outstrips the currently available supply, there are even reports of some producers promoting fake “recycled” plastics to fill the void.

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In this UL white paper, we’ll evaluate the current challenges in expanding the use of recycled plastics. We’ll also discuss how UL is working with industry to increase overall confidence and trust in the safety and sustainability of recycled plastics in a global circular economy.

The consequences of plastic waste

It's almost impossible to imagine our world without plastics. Plastics can be found in almost every product we use today, from food packaging, toys and consumer electronic devices to child safety seats, bicycle helmets and airbags in automobiles. Plastics are used in the clothing we wear, in the construction materials used to build our homes and workplaces, and even in the components of life-saving medical equipment and devices. And advances in new plastic compositions will help drive product innovation for the foreseeable future.

But here's the problem. Currently, the world recycles only between 14-18% of the total volume of plastics that we produce.[1] (For comparison, the recycling rate for paper is estimated at about 58%, while the recycling rate for iron and steel is between 70-90%.[2]). With global production of plastics in excess of 300 million tons annually (a number that's projected to double in the next 20 years),[3] that means that more than 246 million tons of plastic waste are being incinerated or transported to landfills each and every year.

Unfortunately, a significant portion of disposed plastic waste finds its way into our waterways and eventually our oceans. Current estimates place the volume of plastic waste in our oceans at over 150 million tons, with an additional 8 million tons leaking into oceans each year. Without further intervention, the volume of plastic waste in our oceans will be three times greater by weight than the volume of fish and other aquatic life by the year 2050.[4]

The issue with plastic waste is not limited to post-consumer materials. While the intent of circularity is to eliminate waste entirely as part of an efficient production system, real world manufacturing often results in discarded scrap material that may be reprocessed and considered pre-consumer or post-industrial recycled content.

Government efforts to reduce plastic waste are increasing

The widespread use of plastics and the projected explosion in the global production of plastics has brought increased focus to the growing problem of plastic waste. Environmentalists have long voiced concerns about the environmental impacts associated with plastic waste and have argued for restrictions on single-use plastics (most widely found in plastic packaging intended for consumer products). But it was China's implementation of its Blue Sky/National Sword policy (also known as the Green Sword policy) in early 2018 that inadvertently brought global attention to the problem of plastic waste.

In the 20 years prior to the implementation of its National Sword policy, China had become the global leader in the importation of recyclable materials, including metals, paper and plastics. But growing concerns regarding contamination rates associated with imported recyclables led China's Ministry of Environmental Protection to restrict imports on dozens of categories of recyclable materials including certain types of plastic waste. The ultimate goal of these restrictions is to reduce China's overall contamination rate from recycled imports to 0.5% by improving the quality of recyclable materials permitted into the country.

Since its implementation, China's National Sword policy has created a tsunami in the global recycling marketplace. Recycling exporters have been forced to find supply chain partners outside of China, or to integrate recycling processing into their own internal operations, or to cease accepting recyclable materials for which there is no market. And producers have been forced to give increased attention to the quality and recyclability of the plastic and plastic materials used in their products.

China's National Sword policy has also spurred legislative and regulatory efforts to address the recycling marketplace. According to a report issued by the United Nations' Environment Programme, nearly one-third of UN-member countries now require producers of single-use plastics to institute extended producer responsibility measures, such as product take-back schemes, deposit and refund policies and waste collection options.[5] In addition, the European Union (EU) and other governments are advancing rules to improve the recyclability of plastics, investing in the infrastructure needed to enhance separation and sorting required to produce higher quality recyclate, and supporting innovation.

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Industry is making commitments as well

At the same time, global producers and retailers are stepping up and voluntarily embracing initiatives to reduce plastic waste and to shift their future use of plastics. The Alliance to End Plastic Waste, a nonprofit, industry-led initiative, was established in 2018 to address the problem of plastic waste in the environment. The Alliance is specifically focused on:

1. Improvements in the plastics industry's waste management infrastructure e.g., collection, sortation, treatment and recycling efforts
2. Investments in new technologies that minimize plastic waste and make recycling efforts easier
3. Cleaning rivers and streams that carry vast amounts of plastic waste to our oceans.

The Alliance is currently comprised of 40 global companies, who together have initially committed to invest $1.5 billion over the next five years to support these efforts. A separate effort is the New Plastics Economy Global Commitment initiative, launched in late 2018 by the Ellen MacArthur Foundation in collaboration with the UN Environment Programme. The Global Commitment initiative is dedicated to finding new ways to produce, use and reuse plastics and plastic materials, and has mapped out a vision for a circular plastics economy defined in part by:

1. The elimination of problematic or unnecessary plastic packaging
2. The application of new reuse models to reduce the demand for single-use packaging
3. Making all plastic packaging 100% reusable, recyclable or compostable

The Global Commitment initiative has already received commitments from more than 450 organizations worldwide. Notably, signatories to the initiative include approximately 200 businesses, including consumer packaged goods companies, retailers and plastic package producers that jointly represent over 20% of the plastic packaging used around the world. In fact, approximately 125 of those signatories have committed to achieving a minimum average of 25% recycled content in the plastic packing they produce or use by 2025 (approximately 10 times the current global averages for recycled content).[6]

Some individual global brands are committing to even more ambitious plastic recyclability goals. Several signatories to the Global Commitment, including a number of major consumer goods manufacturers, food producers and retailers, have pledged that 100% of their plastic packaging will be fully reusable, recyclable or compostable by 2025.[7][8][9] These and other efforts illustrate the breadth and depth of industry's commitment to significantly reduce pollution attributable to plastic waste.

Efforts to recycle plastics introduce other challenges

The efforts to reduce plastic waste by using products with greater percentages of recycled plastic content comes with its own set of challenges. And perhaps the greatest challenge is the fundamental issue of supply and demand.

On the demand side of the equation, there are multiple indicators that clearly point to a significant increase in the future anticipated demand for recycled plastics and plastic materials. To cite just two examples, one 2019 analysis of the recycled plastics market predicts that global demand will exceed $50 billion (USD) by the year 2024, a compound annual growth rate (CAGR) of over 6%.[10] A separate report released in late 2019 estimates even greater growth during a comparable period, with a projected global market of more than $66 billion by 2025, a CAGR of nearly 7%.[11]

On the other hand, on the supply side of the recycled plastics equation, there are troubling indicators about our ability to keep up with the anticipated demand for consistent quality recyclate. A report issued by New York-based investment Closed Loop Partners on the state of supply chains for plastics and plastic materials estimates that the global demand for recycled plastics will reach 5 to 7.5 million metric tons annually by 2030. However, to meet the anticipated demand, industry will need to ramp up current production capacity by 200-300% in the near term.[12]

Further evidence of the limits of the current infrastructure to safely process and recycle plastic waste includes assessments by researchers in the United Kingdom, who estimate that the country currently has the capacity to recycle only about 9% of the more than 3.3 million tons of plastics consumed annually.[13] And the global consultancy McKinsey & Company cites low recycling system capabilities in the U.S. and elsewhere as a critical impediment to the production of recycled plastics.[14]

Clearly, addressing this growing demand/supply gap for recycled plastics and plastic materials is a high priority for the plastics and recycling industries. In the meantime, the impacts of the current gap are already evident. For example, lack of material supply tends to drive up pricing for that material. When virgin plastic materials are less expensive than recycled plastic alternatives, the economic choice is a simple one for many producers.

The demand/supply gap can also lead to fraudulent practices by some producers. Often, claims regarding recycled materials are difficult to confirm visually or to verify through testing, making it easier for unscrupulous parties to make false or inflated claims regarding the environmental attributes of their products and materials.[15]

Quality and safety considerations in producing recycled plastic materials

Producing quality recycled plastics and plastic materials that are also safe to use is essential for acceptance by end-product manufacturers and consumers alike. At a minimum, specific aspects of plastic waste that can directly impact the quality or safety of recycled plastics include the following:

Polymer-related issues

Plastics used in consumer and industrial products are typically comprised of one or more synthetic polymers. Among the most common polymers are polypropylene (PP), polyethylene terephthalate (PET), high- and low-density polyethylene (HDPE and LDPE), polyvinyl chloride (PVC), and polystyrene (PS).

Each individual synthetic polymer type has unique characteristics and can degrade at rates that are different from seemingly similar polymers. If not rigorously controlled, the process used to create polymers can also allow impurities to infiltrate the finished polymer, further compromising its integrity. And the use of polymer blends can sometimes result in cross-contamination in the finished recycled plastic product or material.

The presence of chemical additives or other substances of concern

During the plastics compounding process, chemicals and other substances are sometimes added to the polymer mixture to enhance certain aspects of the final plastic product, such as strength, flame retardancy and durability, or to reduce premature degradation.

The recovery and recycling of plastics with chemical additives can trigger the release of potentially harmful substances into the environment. In addition, these chemicals may be transferred into the final recycled plastic or material during the recycling process, potentially exceeding thresholds established for the virgin material.

Uniformity and consistency of plastic waste supply

Plastic waste comes in all shapes and sizes, from water bottles and food packaging to plastic, lumber and disposable medical devices. But municipal post-consumer waste collection and sorting activities are not uniform, potentially resulting in the unintended mixing of different types of plastic waste. As China's experience amply illustrates, the mixing of various types of plastic waste can lead to cross-contamination, which not only compromises the quality of the resulting recycled plastics and plastic materials but also poses potential safety risks to workers in recycling facilities.

Current efforts to improve the quality and safety of recycled plastics

Fortunately, important efforts are already underway to identify methods to improve the quality and safety of recycled plastics and plastic materials. Participants from governments, the recycling industry and even consumer product companies that rely on plastic packaging materials to bring their products to market have initiated extensive research into this important issue, with the goal of finding innovative ways to address the problem.

Here are just a few examples:

- The recycling industry is quickly introducing a wide range of advanced technologies, such as robotics and artificial intelligence, to the collection, sorting and recycling process, making it possible to produce higher-quality recycled plastics and plastic materials while reducing the risks of contamination.[16] [17]
- The petrochemical industry is exploring new ways to use advanced chemical recycling processes that revert plastics back to their original chemical components, such as crude, naphtha, ethylene and styrene, that can then be used in new consumer products.[18]
- A team of Swedish scientists have developed a technique involving heating discarded plastic until it turns into a gaseous mixture, which can then be recycled at the molecular level into new plastics of near-virgin quality.[19]
- The U.S. Department of Energy (DoE) has launched its Plastics Innovation Challenge. The goal of the Challenge is to draw on the combined research capabilities of national laboratories, universities and industry to spur further innovations in energy-efficient plastic recycling technologies along every stage of the recycling process.[20]

In addition to these and other efforts, the Association of Plastic Recyclers (APR) has issued "The APR Design® Guide for Plastics Recyclability."[21] First published in 2018, the APR Design® Guide provides comprehensive guidance for plastic packaging design engineers on the use of the most common types of plastics found in collection and recycling systems. APR has also established a process for endorsing third-parties that certify post-consumer resins (PCRs) to support increased access to high-quality recycled plastic resins.[22]

Separately, the EU Post-Consumer High-Tech Recycled Polymers for a Circular Economy (PolyCE) project is a multi-year, multi-stakeholder demonstration initiative funded under the EU Horizon 2020 program. The PolyCE project focuses on the feasibility of circular plastics supply and value chains as they specifically relate to waste electrical and electronic equipment (WEEE) plastics. The project has brought together more than 20 key participants from research, business and technology, working together to reduce WEEE-related plastic waste.[23]

How UL is working to increase trust in the quality and safety of recycled plastics

In the end, addressing the various aspects of recycled plastics is essential to increasing their acceptance and use. Toward that end, UL has been at the forefront of efforts to provide a range of objective mechanisms that can be used across the entire plastics value chain to verify the quality, safety and sustainability of recycled plastics, so that manufacturers, brand owners and end users feel confident in the performance and credibility of the materials.

Our holistic approach is perhaps best exemplified by the array of UL standards and claims validation procedures that have been developed to address the multifaceted aspects of recycled plastics and other recycled materials. Here is just a brief sampling of UL standards currently available:

UL 746D, Standard for Polymeric Materials
Fabricated Parts Edition 8 —This standard evaluates plastics with recycled content (pre- or post-consumer or post-industrial) for compliance with UL safety standards so they can be used in components and end products where UL requirements are defined.

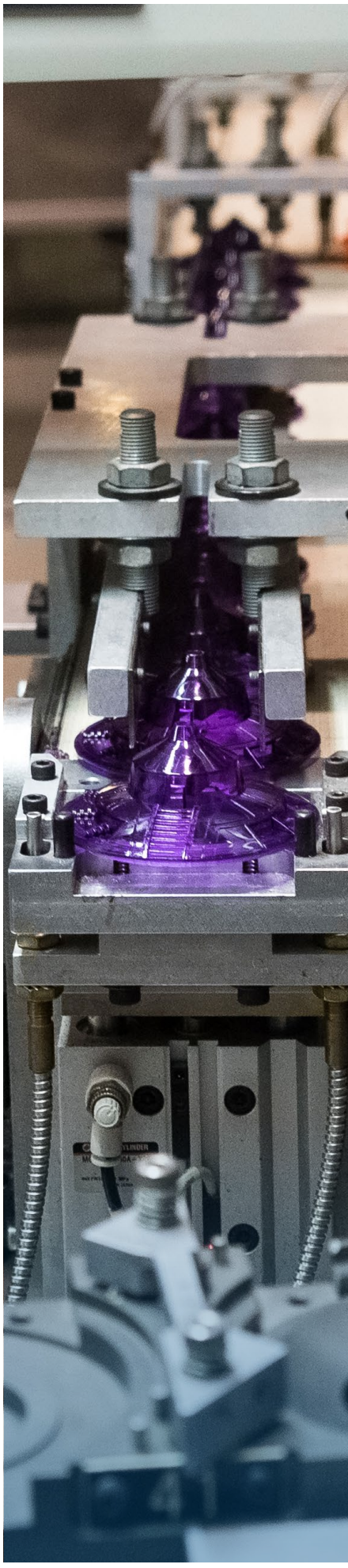
UL 2789, Environmental Claim Validation Procedure for Calculation of Estimated Recyclability Rate (Edition 2)
UL 2789 involves evaluating the recyclability of a product's individual component parts and materials, including plastics, metals, glass and batteries. This evaluation serves as the basis for validation of recyclability claims for the entire product.

UL 2799, Environmental Claim Validation Procedure for Zero Waste to Landfill (Edition 3)
This standard addresses the monitoring and measuring of waste material flows in facilities (including manufacturing), with the goal of minimizing waste diverted to landfills. Certification to UL 2799 requires that at least 90% of waste is diverted through methods other than waste-to-energy, encouraging a greater emphasis on recycling efforts.

UL 2809, Environmental Claim Validation Procedure for Recycled Content (Edition 5)
UL 2809 provides a framework for the comprehensive evaluation and validation of recycled content in a product, including pre- and post-consumer recycled content. The fifth edition of the Standard also includes procedures for assessing ocean-bound plastic recycled content.

UL 2990, Environmental Claim Validation Procedure (ECVP) for By-Product Synergy (Edition 1)
UL 2990 is intended to help producers secure market recognition for incorporating the wastes from another producer into their production process.

UL 3600, Outline of Investigation for Measuring and Reporting Circular Economy Aspects of Products, Sites and Organizations (Edition 1)
This outline addresses many of aspects of the previously listed standards dealing with recycled content, design for recyclability and zero waste.



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In addition to ongoing standards development efforts, UL offers the UL Yellow Card Plastics Recognition program. The Yellow Card program includes the testing of plastics for compliance with applicable regulatory standards, as well for conformity with the performance requirements of original equipment manufacturers (OEMs).

UL's Fabricated Parts Traceability Program for polymeric materials supports supply chain integrity and end-user sourcing requirements through quarterly audits of fabricators (molders/processors/printers) to help ensure the correct materials are being processed according to UL requirements without modification or adulteration.

UL Prospector®, PurView®, WERCSmart®, and Cheminformatics represent our suite of software solutions that enable the plastics industry to drive intelligent innovation, intelligent compliance and intelligent promotion. We accelerate product development by helping part designers identify and select recycled content materials.

Finally, UL has actively worked with the Fraunhofer Institute for Reliability and Microintegration (IZM) since 2017, sharing its expertise in the validation of recycled content claims in support of the previously mentioned EU PolyCE program. It is expected that this and other collaborations will help to increase the supply and availability of quality recycled plastics, while also contributing to UL's larger goal of supporting the shift toward a worldwide circular economy.

Conclusion

As the demand for recycled plastics and materials continues to increase, producers and OEMs need objective standards and methods for verifying their safety, quality and sustainability. In some cases, social and labor aspects with the collection of recycled materials for feedstocks is also critical. UL continues to play an essential role in efforts to reduce the impacts of global plastic waste and to foster the increased use of quality and safe recycled plastics in all types of products by developing standards that address performance, sustainability and that evolve to address social issues and new technologies. These efforts to address the challenges of plastic waste represent just one aspect of our commitment to promote a circular approach in achieving the goals of environmental health and safety and global sustainability.

Check out UL's resources for plastics

To view performance testing and certification information: visit UL's Product iQ™ database.

To learn about our Software & Services for Regulatory Compliance, which help companies around the globe reduce risk, reach chemical compliance, promote materials and foster product stewardship; visit MSC.UL.com/en

To see validated environmental claims for plastics, visit SPOT.UL.com.
To download UL standards and validation procedures, visit shopulstandards.com.

For more information on how UL can assist your organization in its assessment of the quality, safety and sustainability of recycled plastics, visit us at UL.com.

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