Developing Sustainable Consumer Products Through Sustainable Chemistry

UL Solutions

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Introduction

Today's manufacturers and retailers face many challenges in developing and selling safe and sustainable products. This has led to sustainability programs to improve the social, environmental and health impact of the product materials, manufacturing processes, and use, reuse and recycling. Products must not only be safe for their intended use, but consumers demand they be made through carbon-neutral manufacturing processes, do not negatively affect human health or the environment, and are manufactured under socially responsible labor conditions — all attributes of sustainability.

While the concept of sustainability continues to expand in scope, a key aspect of sustainability, namely chemical sustainability, is often overlooked. Developing sustainable consumer products includes understanding their chemical composition and ensuring these chemicals are manufactured sustainably (e.g., using less water, energy and being carbon-neutral) and are not harmful to humans and the environment. Collectively, these can be called green chemicals. Therefore, sustainability practices can also include the application of sustainable chemistry and green chemistry that follow the 12 principles discussed below.

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More chemicals are being phased out through government action and, increasingly, by global awareness campaigns and consumer blogs that discuss the toxicity of chemicals, such as their carcinogenic effects. As consumers become more aware of chemical toxicity and product safety, they are met with an increase in products marketed as sustainable. The green chemicals industry will likely continue to grow to meet this demand. The global green chemicals market is forecast to grow at an 8.9% compound annual growth rate (CAGR) between 2020 and 2030.[1]

Selecting sustainable chemicals

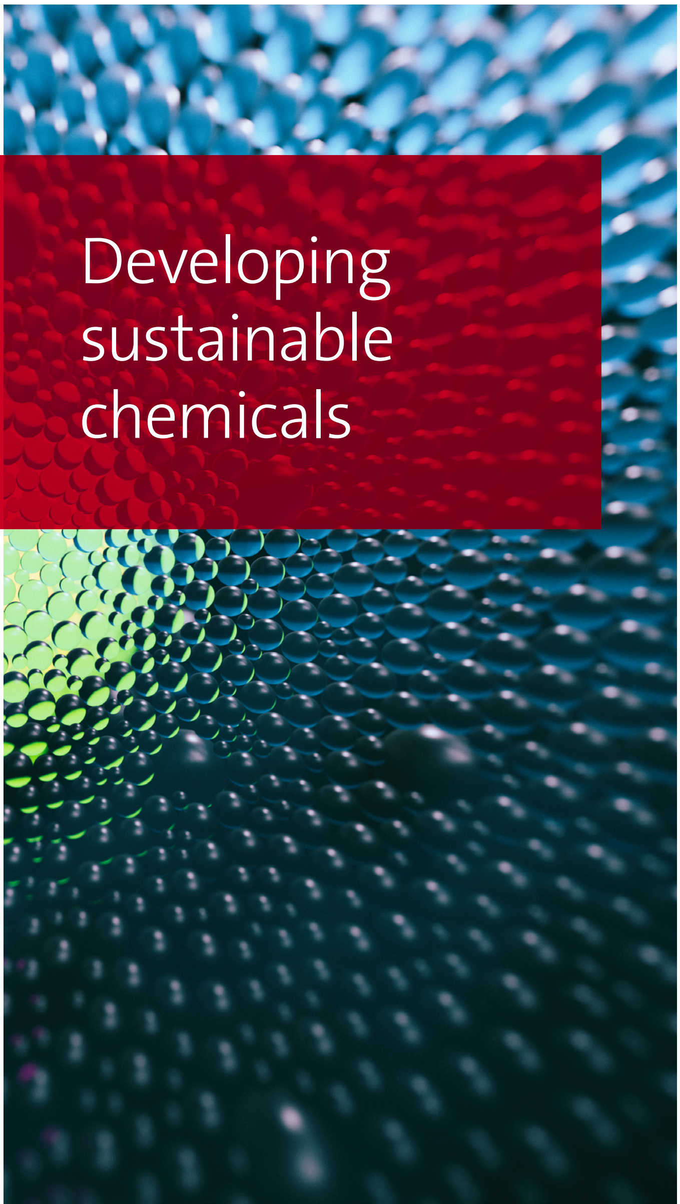
Developing more sustainable products can involve reformulating materials to replace problematic chemicals. The process should begin by checking the multiple Manufacturing Restricted Substance Lists (MRSL) containing banned and restricted chemicals that should not be used in the manufacturing process. Restricted Substances Lists (RSL) provide companies with information related to regulations and laws that restrict or ban certain chemicals and substances found in consumer products around the world. For example, the European Chemicals Agencies restricted substances list[2] contains banned and restricted problematic chemicals that limit their use in finished products and/or components. Searching for alternative chemicals to replace banned or restricted chemicals is complex. Manufacturers need to consider many factors to determine if an alternative chemical meets the same or similar necessary functional properties while having a more favorable hazard profile and being economically feasible. In addition, not all problematic chemicals are found on MRSLs or RSLs. Therefore, these chemicals need to be assessed for undesirable hazards, which requires a chemical hazard assessment for potential unacceptable human health and environmental hazards and should not be used as a replacement for restricted or banned chemicals. There are numerous chemical alternative assessment frameworks, such as GreenScreen® for Safer Chemicals[3], that provide guidance on conducting chemical hazard assessments and the relative comparison of chemicals to one another to help in the selection of the most sustainable chemical alternative.[4]

As experience with these alternative assessment frameworks increased, it's become clear that no one framework can be considered the best. Therefore, the Organisation for Economic Co-operation and Development (OECD) has recently published guidance on key considerations for the identification and selection of safer chemical alternatives.[5] The guidance is aimed at establishing and advancing minimum requirements (both criteria and assessment practices) for safer determinations in four core areas:

- Determining the assessment's scope
- Comparative hazard assessment
- Comparative exposure assessment
- Integrating hazard and exposure to select a safer alternative

The OECD guidance emphasizes that hazard and exposure are key considerations and, as such, follow the principles of risk assessment rather than hazard assessment alone. RSLs and Chemical Alternative Assessment frameworks are included in some UL sustainability Standards, for example, UL 110, the Standard for Sustainability for Mobile Phones, and ECOLOGO® Standards for formulated products.

Developing sustainable chemicals



If no alternative chemical is available to replace a problematic chemical, then a new chemical might need to be manufactured. To develop a suitable new alternative chemical, principles of green chemistry and sustainable chemistry provide useful guidance for the development of a suitable alternative or green chemical. Sustainable chemistry and green chemistry are terms frequently used interchangeably, but there are some differences. The 12 principles of green chemistry (see inset) focus on designing and manufacturing chemicals more sustainably with lower hazard profiles without sacrificing functional properties and economic viability.[6] The 10 key characteristics of sustainable chemistry (see inset) is a more recent and comprehensive framework that considers the role of chemicals within a circular economy of products[7] — it incorporates green chemistry but also considers whether chemicals and materials can be replaced through changes in product designs and even whether the product can be replaced through other services or approaches. Whatever approach is followed, the outcome should be the development of green chemicals with acceptable human health and environmental safety profiles.

Key characteristics of sustainable chemistry

1 Holistic
2 Precautionary
3 Systems thinking
4 Ethical and social responsibility
5 Collaboration and transparency
6 Sustainable and responsible innovation
7 Sound chemicals management
8 Circularity
9 Green chemistry
10 Life cycle

The 12 principles of green chemistry

1 Prevent waste
2 Less hazardous chemical syntheses
3 Safer solvents and auxiliaries
4 Use of renewable feedstocks
5 Catalysis
6 Real-time analysis for pollution prevention
7 Atom economy
8 Designing safer chemicals
9 Design for energy effciency
10 Reduce derivatives
11 Design for degradation
12 Inherently safer chemistry for accident prevention

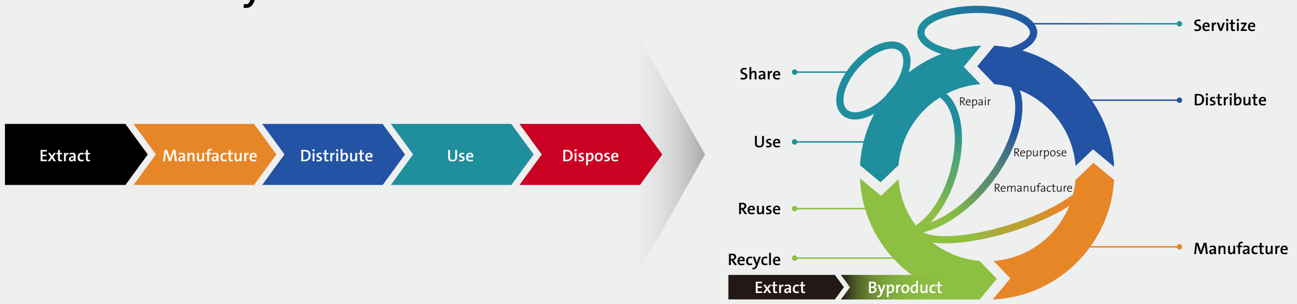
Using sustainable chemicals

Sustainability practices are moving toward a circular economy, which is an economic model designed to produce safe and useful products while minimizing resource inputs, waste and emissions. Circularity is much more than recycling or landfill diversion. Circularity looks at the whole value chain to reduce the use of virgin resources — keeping all materials and products in circulation as long as possible, creating as much value as possible and recycling components or materials into new products at the end of each product or service life. Additionally, it's about using renewable energy, reducing greenhouse gases and more.

Some approaches to developing circular products are to manufacture products using recycled materials as raw ingredients. To ensure the material is safe to humans and the environment, it is essential to characterize recycled raw ingredients and the composition of materials made with recycled content for problematic chemicals retained or created in the recycling processes. Using green chemicals to manufacture virgin raw ingredients reduces the chance that problematic chemicals are retained in the recycling process for making recycled raw ingredients. The chemical formulations, chemical contaminants and chemical byproducts of recycled raw ingredients and materials will need to be disclosed while maintaining confidentiality to protect intellectual property. Producers of recycled raw ingredients will continue to be under pressure from brand owners to demonstrate the allowed limits of restricted substances and the performance characteristics of recycled raw ingredients and materials containing these through testing, verification and certification. Where recycling is not feasible, efforts are underway to develop materials that can rapidly biodegrade when disposed.

Because conventional plastic materials can take upwards of 1,000 years to degrade in a landfill, manufacturers are attempting to develop materials designed to be easily and rapidly biodegradable and compostable.[8] While biodegradability is defined in several ASTM, ISO, EN and OECD standards, there is still discussion over how well those standards match actual conditions and predict biodegradation in industrial composting and anaerobic digestion systems. Achieving biodegradation of materials in products has been difficult to complete as they are rarely exposed to the appropriate conditions to biodegrade. In addition, there are emerging concerns that biodegraded plastics can release microplastics and problematic chemicals into the environment with potentially negative health and environmental consequences. So, designing biodegradable materials includes ensuring the biodegraded materials can completely biodegrade and create waste consisting only of green chemicals. To develop biodegradable materials that are part of the solution, there is a need for collaborative research between material manufacturers and standards organizations. Together, they must work to establish the necessary conditions for demonstrating effective and safe biodegradation and then using that knowledge to develop standards relevant to real-world conditions. Even so, there is a place for biodegradation for some classes of products in the circular economy when those products are handled properly at their end of life.[9]

Circular economy



Conclusion

Manufacturing sustainable products through sustainable chemistry brings many challenges. As chemical regulations continue to increase and voluntary restricted substance lists expand, knowing what chemicals make up the materials in products is essential. These chemicals must comply with regulations. They should not be problematic chemicals found on MRSLs or RSLs or problematic chemicals not yet on MRSLs or RSLs. In addition, these chemicals must be recyclable or biodegradable while being acceptable to consumers and retailers. Taken together, these considerations create an enormous task. It requires that data be easily shared across supply chain partners at every stage of the process. Technology for end-to-end supply chain traceability and transparency will be necessary if this is to become a reality. These technology solutions exist and are increasingly connecting the nodes of the value chain together as data-sharing standards are developed that maintain confidentiality. Moreover, third-party certification for product performance, safety, reliability of sustainability claims, and ingredient and product traceability across the supply chain will demonstrate manufacturers' commitment to sustainability.

To learn more contact us or check our website UL.com/Solutions

How UL Solutions is working to increase trust in the quality, safety and sustainability of products

UL Solutions has been at the forefront of efforts to provide a range of services that can be used across the product value chain to verify the quality, safety and sustainability of ingredients, materials and components to ensure manufacturers, brand owners and end-users feel confident in the performance, safety and sustainability of these products.

UL Solutions offers an array of certifications and claim validation based on standards and claims validation procedures. Additionally, we develop testing and digital solutions to address the multifaceted aspects of designing, manufacturing and using sustainable products. The following is a brief sampling:

Zero Discharge of Hazardous Chemicals (ZDHC) Certification and Testing Programs help manage textile, leather and footwear supply chains to reduce the use and amount of hazardous chemicals that are discharged to protect consumers, workers and the environment.

UL Certification of materials includes complete solutions that can assess the safety, performance and sustainability of plastics and engineered materials.

Supply chain insights help transparency and end-to-end compliance in all stages of the product life cycle — from innovation and market entry to product disposal. UL Solutions offers global compliance expertise, data and advanced software solutions to help enhance safety, increase productivity, reduce costs and strengthen brands.

Digital solutions/product stewardship programs go beyond regulatory compliance by proactively developing and selecting safer and sustainable materials, products and suppliers. Product stewardship programs aim to minimize the negative environmental, health, chemical safety, and social impacts of a product throughout its life cycle.

ESG and sustainability management software platforms help businesses track and measure environmental, supply chain, health and safety management and sustainability data to meet regulatory and disclosure needs.

UL Certication on products helps pursue ways to make your products healthier and more sustainable.

Key UL Standards

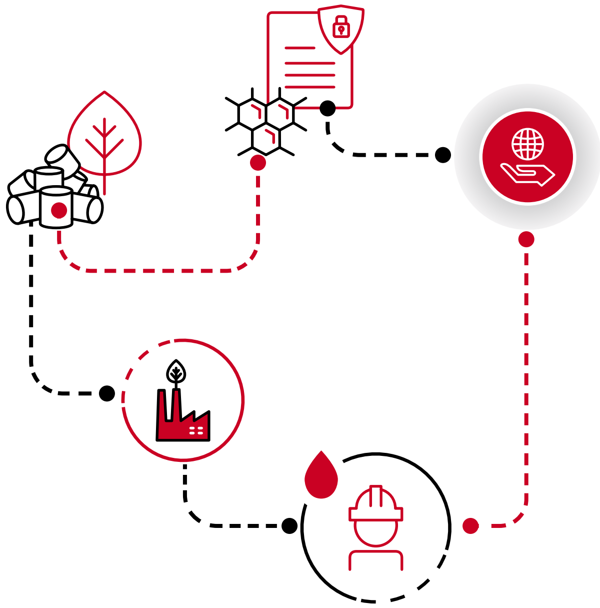
UL 746D: The Standard for Polymeric Materials - Fabricated: This standard evaluates plastics with recycled content (pre- or post-consumer or post-industrial) for compliance with UL safety Standards so they can be used in components and end products where UL requirements are defined.

UL746H: Outline of Investigation for Non-Halogenated Materials: This outline covers testing and evaluation requirements for the assessment of combustible materials, including insulating materials and devices (e.g. plastics, printed-wiring boards, insulating materials and systems, labels, tape, tubing, and sleeving), color concentrates and wire and cable compounds intended for various applications as non-halogenated or non-chlorine and non-bromine.

UL 746R: Outline of Investigation for Restricted Use Substances in Polymeric Materials, Issue 4: This Outline covers testing and evaluation requirements for the assessment of polymeric materials with regard to the presence of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), bis(2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP) and diisobutyl phthalate (DIBP) with respect to the maximum concentration levels specified in Directive 2011/65/EU of the Europeawwn Parliament and of the council of June 8, 2011, on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) and the commission delegated Directive 2015/863 amending Annex II to Directive 2011/65/EU.

UL 2885: Outline of Investigation for Acid Gas, Acidity and Conductivity of Combusted Materials and Assessment of Halogens: This outline covers testing and evaluation requirements for the assessment of individual combustible materials used in wire and cable constructions with regard to their acid gas combustion emission characteristics and determination as halogen-free.

UL ECVP 2789: Environmental Claim Validation Procedure for Calculation of Estimated Recyclability Rate (Edition 2): This Procedure 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 the validation of estimated recyclability rate claims for the entire product.



UL 2799: Environmental Claim Validation Procedure (ECVP) for Zero Waste to Landfill (Edition 3): This Procedure 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 and landfill, encouraging a greater emphasis on recycling efforts.

UL ECVP 2809: Environmental Claim Validation Procedure (ECVP) for Recycled Content (Edition 5): This Procedure 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 and multiple Chain of Custody models as defined in ISO 22095.

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

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