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Reducing plastic waste: why choosing the right material isn't as simple as you think

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Single use plastics are, undoubtedly, a hot topic. Plastic waste represents one of the biggest global threats to our natural habitat, for example, there are more than 8 million tonnes of plastic entering the world's oceans every year. The effect this is having on the world's coastlines, marine life and our own wellbeing has reached devastating levels, with new evidence of harm being regularly publicised and creating nothing short of a global emergency.

Public perceptions of plastic bottles, straws and packaging are continuously getting worse and worse. Over the last decade consumers have begun to pay real attention to plastic usage and waste, with the topic now ever present on popular news and social media. Consumer perception of plastics is starting to be reflected in purchasing habits, with consumers either choosing not to buy certain single use plastic products or actively seeking out alternatives that are more sympathetic to the environment.

However, this has not translated into a global reduction in plastic waste, with production of plastic waste increasing by 5% year on year. The reality is that our reliance on single use plastics continues to grow globally, so how do we break this destructive cycle in a way that satisfies both industry and consumer demand?

We are beginning to pull our heads from the sand and accept that recycling plastic is not going to remedy this colossal, worldwide problem. The world is waking up to the stark reality of the plastic problem, with some notable regulatory restrictions having valuable impact, but most recycling initiatives have failed.

The wider challenge of creating a truly sustainable circular economy seems like a distant future. For the small percentage of plastics that are correctly disposed of, cleaned and sorted, they are normally down-cycled, meaning that they will never able to be used in the same product (or a product of the same quality) as they were originally. On top of this, the energy and costs associated with the transporting and processing of plastics means that this will never be a sustainable solution.

Because of this, many companies are now actively looking for market advantage by moving away from single use plastics – driven either by a sense of corporate responsibility or a need to meet the growing demands of their increasingly frustrated customers. But, with the favourable durability, chemical compatibility and versatile characteristics of plastics, finding an alternative is much harder than you might think.

Companies come to us when they want to reduce their products' environmental impact. We often find that the challenges are around changing the current material while preserving current forms and the comparable cost of goods sold. Balancing multiple inputs from marketing, engineering and procurement teams, Sagentia explores all possibilities to find a solution that meets the requirements of all the stakeholders.

The challenge in replacing plastic can be illustrated by considering two alternative, but well-established materials for beverage packaging: aluminium and paper pulp.

Aluminium is superior to plastic as it can be infinitely recycled, and the infrastructure is well established thanks to the huge numbers of beverage cans and consumers' familiarity with recycling them. Despite still requiring a large amount of energy to recycle aluminium, the output is the same quality as the input meaning it can be re-used for the same purpose indefinitely. As a uniform and consistent material, it is attractive to recycling plants, so it is actually more likely to be recycled.

Multiple iterations of a design can demonstrate innovative approaches to topology and seaming, leveraging the benefits of multiple manufacturing processes. However, achieving the same product shape, size and wall thickness with these aluminium is highly challenging. In this context, it is necessary to consider a wider variety of manufacturing techniques, such as deep drawing, redrawing and impact extrusion.

Additionally, to create a closed shell to seal the fluid inside the aluminium container requires rolled seams which are often not easy to fit into the established design aesthetic of the plastic product. One solution is to make a feature of this seam, incorporating it into the product's visual language and promoting the improved recyclability of aluminium. In this way we can reconcile the practical realities of using this material with the consumer-facing requirements of a packaging product.

Paper pulp is a material which is both recyclable and biodegradable, as well as being readily manufactured from recycled paper. These are very appealing characteristics, and many start-ups have proposed all-paper bottles, as yet without success.

Paper pulp has been widely used for a long time in packaging applications where structure is more important than aesthetics as it can be easily vacuum formed to a wide variety of shapes. We have investigated available pulp forming techniques which are capable of achieving a greater level of outer surface quality, finishing and decorating with the aim of matching the vibrant, glossy aesthetic of a traditional plastic packaging design. This on shelf presence and compatibility with existing printing and labelling techniques, as well as compatibility with existing transportation and logistical operations confers a significant advantage for paper pulp over other alternative materials.

Moreover, there has also been a considerable effort to develop pulp to suit a wider range of applications, with a notable focus on creating a pulp packaging which is watertight. In its natural form, paper can only hold water for a few minutes before degrading structurally with plastic coatings extending this time to several hours for single use coffee cups. Putting a plastic liner in the bottle immediately destroys the appeal of a pulp-based package and makes composting or recycling impractical.

There are several good candidates for plastic-free paper cups that give a useful life for drinking a cup of coffee. The real challenge lies in developing a paper-based package which can hold a range of liquids with shelf lives suitable for a consumer market – typically a minimum of a few months, up to several years. There have been many players tackling this challenge over recent years (and indeed, continuing for years to come) with solutions falling into three main categories: laminated paper, bag-in-box constructions and internal/external linings.

The first two of these can provide seemingly viable solutions, for example TetraPak who have a strong track record of paper-based cartons. But on closer inspection, these products are generally unattractive from a sustainability point of view.

This means that the barrier must be dissolvable by the solvents used in the re-pulping process in a short time scale (typically less than 7 minutes) – clearly conflicting with the liners ability to contain harsh liquids for many months.

So, are there any materials suitable which can meet both the repulping and long shelf life requirements of typical bottled products? Surprisingly, one of the most promising technologies is a simple modification to a conventional plastic film liner - Mineral filled polyethylene has a valuable combination of enhanced barrier properties and ability to mechanically break up in a recycling digester.

This technology has been developed to target the real world challenge of working within the paper recycling ecosystem and meet the existing repulping criteria and other relevant regulations. Combining two extremely common and safe materials (PE and calcium carbonate) is an excellent basis for meeting concerns about safety and food compatibility.

In conclusion, meeting all the required standards for pulp as an alternative packaging solution to plastic can be challenging, and careful analysis and creativity is required to identify the best option for each specific application.

With no examples of market ready products in this area, it's clear there is still a lot of work to do. But as demand continues to grow, the race to develop the first truly sustainable pulp packaging continues.

About Sagentia

Sagentia is a global science, product and technology development company. Our mission is to help companies maximize the value of their investments in R&D. We partner with clients in the medical, consumer, industrial and food & beverage sectors to help them understand the technology and market landscape, decide their future strategy, solve the complex science and technology challenges and deliver commercially successful products.

Sagentia employs over 150 scientists, engineers and market experts and is a Science Group company. Science Group provides independent advisory and leading-edge product development services focused on science and technology initiatives. It has ten offices globally, two UK-based dedicated R&D innovation centers and more than 400 employees. Other Science Group companies include OTM Consulting, Oakland Innovation, Leatherhead Food Research, TSG Consulting and Frontier Smart Technologies.

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