Plastics picnic at Hanging Rock

As PureCycle's ultra-pure recycled polypropylene resin prepares to scale up, **Dominique Huret** visits the company's plant in Ohio to find out how it works

A pledge for 100 per cent recyclable or reusable packaging by 2030 was one of several commitments made by Procter & Gamble (P&G) in its 'Ambition 2030' campaign to reduce, reuse and recycle.

But as the campaign against plastics continues to gather momentum, P&G made an additional commitment last April: to halve its global consumption of virgin petroleum plastics in packaging by 2030.

How will the world's largest personal- and home-care brand owner achieve this? By pursuing light-weighting of course, increasing recycled content, proposing concentrated or other types of products and in specific cases, using alternative materials.

Plastics in Packaging journeyed to Hanging Rock in Ohio (USA) to visit P&G's most innovative recycling technology at work. Here, Dr John Layman, P&G's section head for global sustainable materials and founding inventor behind PureCycle Technologies, outlined how the company is scaling up the PureCycle multi-million-dollar investment (estimated around $25 million).

P&G is actively focused on maximising the amount of post-consumer recycled (PCR) plastics in its bottles and packages. In Europe, it targets 25 per cent PCR content in its three major hair-care brands, while it anticipates reaching between 25 and 50 per cent content in fabric-care and 20-70 per cent in its home-care brands.

Today, many of P&G's packages use polypropylene (PP). In the US, the demand for recycled PP is estimated at 1 billion pounds (454,000 tonnes), with 720 million pounds (327,000t) of that demand said to be for 'high-quality' recycled PP. But the volumes currently available in the market today are much lower.

"With a PhD in polymer science, I started working in 2012 on a new way to recycle PP in P&G's Boston Gillette R&D laboratories," Layman explained. "The project was code-named 'Wall-E' for the Disney animated film about a robotic hero who cleaned the planet. It wasn't enough to develop a solution at the bench-scale. It had to be a techno-economically viable solution that could be scaled to meet global demand."

After achieving some very promising initial results, the project earned the moral support of P&G's senior R&D leadership, including chief R&D officer Kathy Fish. "However, as P&G is not a polymer producer, I was advised to find a partner to bring the process to life," he added.

In 2015, PureCycle came to an agreement with P&G to obtain an exclusive license to scale up the technology globally. PureCycle quickly identified a decommissioned Dow polystyrene site as the place to locate the first plant. PureCycle moved quickly to conduct additional trials and finalised the design basis for the Feedstock Evaluation Unit (FEU), breaking ground in 2017.

On the nearly three-hour drive from Cincinnati to the Ironton plant, Layman explained the recycling process: "In classic chemical

Above left: Dr John Layman shows a schematic of the future Ohio site to be fully operational in 2021. Above right: Before and after: PP carpet agglomerate vs PureCycle rPP

The PureCycle team demonstrated the technology in July 2019. From left to right: Jason Vititoe (technology director), Dr John Layman (P&G's section head for global sustainable materials), and Tayt Rule (chief operating officer)

Below: The PureCycle team poses inside the FEU

depolymerisation, a chemical reaction occurs when then polymer is depolymerised back into monomer. The PureCycle process is different, as purification is a physical process that uses a petroleum-based solvent. It removes migratable impurities using an extraction step, and then clears away non-soluble contaminants from the rPP using a filtration step. The removal of impurities, odour and colours is accomplished using multiple unit operations, with each step playing a role in removing different sorts of unwanted contamination (dyes, pigments and mineral fillers) from the rPP. The search for the right solvent was key: it had to have pressure- and temperature-dependent solubility properties and of course be safe, in terms of human toxicity."

In early 2019, PureCycle's FEU was completed using existing, 'off-the-shelf' equipment. It was built by Koch Modular Process Systems of Paramus, New Jersey, and comprises successive stages that work together to accomplish purification (feedstock evaluation, melting and filtering, extraction, mixing and setting, filtering, purification and separation). Nine operators currently run the FEU, 24/7 across four shifts.

The purpose of the FEU is to help PureCycle understand how each feedstock flows through the process. The FEU mimics the unit operations and conditions that PureCycle will use at scale when the commercial line comes on-

stream in 2021. With more than 20 billion pounds (9.07 million tonnes) of waste plastics in North America, there is no shortage of feedstock. However, PureCycle has been highly selective in going after feedstock streams that it believes can be maintained in large quantities for long periods of time. This sentiment is echoed across PureCycle.

Tayt Rule, chief operating officer, explained: "Ensuring feedstock flexibility is key to success. We're processing everything from waste carpets to used PP cups to bottle label film to super-sacks."

At the start of July 2019, the team demonstrated that waste polypropylene can be converted into ultra-pure recycled propylene (UPRP), when the FEU produced its first batch from waste carpet. Since then the team has conducted many additional runs, transforming waste PP cups into UPRP.

PureCycle's UPRP can be used in any application where virgin PP is used, including packaging. Potential applications are numerous: tray lids, chocolate bar wrappers, yoghurt pots, meat trays, ice cream, butter and fresh cream pots. When asked what's next for PureCycle, Jason Vititoe, PureCycle's director of technology, said: "We're gearing up for the largest proof-point yet, which is obtaining the FDA Letter of No Object for Food Contact Use. This will allow our resin to be used in the broadest range of products that help to close the loop in recycling."

The FEU has several roles, including screening feedstock as scrap markets change and evolve over time, and developing a product portfolio of samples.

"When at full capacity, the Ironton plant will be able to transform 120 million pounds (54,431 tonnes) of plastics annually, and produce about 105 million pounds (47,627 tonnes) of near-virgin rPP," Layman added. "The final yield of rPP will depend of the contamination level in the various feedstocks."

Companies from across the packaging and cosmetics industries have shown robust interest in the technology over the last two years, and in March this year, Milliken and Nestlé got onboard. The former is playing an active role in reinvigorating rPP with its additives, while Nestlé is keen to explore new packaging materials, in line with its 2025 company commitment to make 100 per cent of its packaging recyclable or reusable.

This summer, L'Oréal and PureCycle reached an agreement for the beauty business to acquire the final share of the Ohio plant's current capacity, with the option of being among the first purchasers of volume from the debut plant in Europe, wherever that may be.

Layman concluded: "At P&G we strongly believe that pre-competitive collaboration is an essential key to unlock the full potential of recycled material. A rising tide raises all ships. But such a revolutionary technology takes a whole village to build."

What he is effectively saying here is that PureCycle's Ironton FEU today is a 'small model plant' to be replicated tomorrow in bigger plants worldwide for a true plastics circular economy.

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