A complex and serious challenge

While growth projections for bioplastics look healthy enough, is the industry anywhere near where it should be? Consulting editor **Adrian Wilson** assesses new developments in the field.

Overall, 2018 was not a good year for synthetic polymer and fibre-based products such as nonwovens.

The issue of microplastics in the oceans generated a mountain of negative publicity and calls for far-ranging action against plastics and at the same time, the publicity surrounding so-called 'fatbergs' continued. Even the humble teabag was the subject of a successful consumer campaign to see the elimination of plastics from it.

AEPW

Following various initiatives from both corporations and government legislators during 2018, on January 16th this year – as noted elsewhere in this issue of *SNW* – Procter and Gamble announced that it was teaming up with 29 other corporations to form the cross value chain Alliance to End Plastic Waste (AEPW), which is immediately committing $1 billion to advance solutions to eliminate plastic waste in the environment, and especially in the oceans.

The Alliance will develop and bring to scale solutions that will minimise and manage plastic waste and promote solutions for used plastics by helping to enable a circular economy.

Its membership includes many companies who are active along the nonwovens supply chain and in addition to P&G, these include BASF, Berry Global, Braskem, Clariant, Covestro, Dow, DSM, ExxonMobil, Formosa Plastics, Henkel, LyondellBasell, Mitsubishi, Reliance Industries, SABIC, Sumitomo and Total.

"Everyone agrees that plastic waste does not belong in our oceans or anywhere in the environment," said David Taylor, Chairman of the Board, President and CEO of Procter & Gamble, and chairman of the AEPW. "This is a complex and serious global challenge that calls for swift action and strong leadership. This new alliance is the most comprehensive effort to date to end plastic waste in the environment. I urge all companies, big and small and from all regions and sectors, to join us."

Total Corbion has now started up its 75,000 tons-per-annum PLA bioplastics plant in Thailand.

Criticism

However, the initiative has inevitably drawn criticism from some campaigners.

"This is a desperate attempt from corporate polluters to maintain the status quo on plastics," said Graham Forbes, global plastics project leader for Greenpeace talking to The Guardian newspaper. "In 2018 people all over the world spoke up and rejected the single-use plastics that companies like Procter & Gamble churn out on a daily basis, urging the industry to invest in refill and reuse systems and innovation. Instead of answering that call, P&G preferred to double down on a failed approach with fossil fuel giants Exxon, Dow and Total which fuel destructive climate change.

"Make no mistake, plastics are a lifeline for the dying fossil fuel industry, and this announcement goes to show how far companies will go to preserve it."

Despite such negativity, there can be little doubt that solutions are being sought with a new urgency.

At its recent Innovation Takes Root conference in San Diego, NatureWorks announced new performance attributes for nonwovens manufactured with its Ingeo PLA.

Seaweed

Bioplastics which don't have petrochemical origins and degrade quickly could provide a partial solution to the plastics problem, although they are also not entirely without an environmental price – to grow the plants or bacteria as raw materials requires fertile soil and fresh water, which many countries don't have in abundance.

With this in mind, scientists are looking to the oceans as the potential source of new raw materials, with projects in Israel and the USA examining seaweed and algae respectively.

Tel Aviv University (TAU) has developed a process to make bioplastic polyhydroxyalkanoate (PHA) polymers from the microorganisms that feed on seaweed. These are biodegradable, produce zero toxic waste and can be recycled into organic waste.

Microorganisms

"Our new process produces new plastic from marine microorganisms that completely recycle into organic waste," said Dr Alexander Golberg of the Porter School of Environmental at TAU. "Our raw material was multicellular seaweed, cultivated in the sea. These algae were eaten by single-celled microorganisms, which also grow in very salty water and produce a polymer that can be used to make bioplastic. There are already factories that produce this type of bioplastic in commercial quantities, but they use plants that require agricultural land and fresh water."

The scientists believe the process they propose will enable countries with a shortage of fresh water, such as Israel, China and India, to switch from petroleum-derived plastics to biodegradable plastics.

"We have proved it is possible to produce bioplastic completely based on marine resources in a process that is friendly both to the environment and to its residents and we are now conducting basic research to find the best bacteria and algae that would be most suitable for producing polymers for bioplastics with different properties," Dr Golberg said.

Algae

Meanwhile, a $2 million grant from the US Department of Energy (DOE) to develop new methods for manufacturing products based on algae has been awarded to a team of biologists and chemists at University of California San Diego.

Project principal investigator Stephen Mayfield of UC San Diego's Division of Biological Sciences will lead efforts to develop novel platforms to produce biologically-based monomers that will be used to manufacture renewable and biodegradable polyurethanes.

"We propose to develop novel algae platforms for the production of one of the key monomers used to make polyurethane polymers, while simultaneously developing basic tools to enable improved algal production systems that will accelerate the process from initial concept to market supply," he said.

The grant is part of a recently announced $80 million DOE Bioenergy Technologies Office initiative supporting 36 projects in bioenergy research and development. In addition to bio-based products, projects include renewable hydrocarbon fuels and power from non-food biomass and waste feedstocks.

Mayfield's laboratory is developing algae for the production of human and animal foods and feeds, and as a platform for the production of recombinant proteins useful as therapeutics or industrial enzymes.

Global production

So much for new research, but what about commercial production and the solutions available in 2019?

European Bioplastics says that global bioplastics production capacity is set to increase from around 2.1 million tons in 2018 to 2.6 million tons in 2023, with PLAs (polylactic acids) and PHAs driving the growth.

PHAs have been in development for a while and are now entering the market at a larger commercial scale, with production capacities set to quadruple in the next five years. These polyesters are bio-based, biodegradable, and feature a wide array of physical and mechanical properties.

Production capacities of PLA are meanwhile set to double by 2023. PLA is a very versatile material that features excellent barrier properties. High-performance PLA grades are an ideal replacement for several conventional fossil-based plastics such as polystyrene and polypropylene.

Total Corbion

In the largest single capacity expansion for bioplastics, Total Corbion PLA, a 50/50 joint venture between Total and Corbion, has now started up its 75,000 tons-per-annum PLA bioplastics plant in Rayong, Thailand.

The plant has successfully produced Luminy PLA (polylactic acid) resin which makes a valuable contribution towards the circular economy, being 100% renewable and biodegradable and offering multiple environmentally-friendly waste solutions.

The new facility will produce a broad range of Luminy PLA resins from renewable, non-GMO sugarcane sourced

locally in Thailand – from standard PLA to innovative, high heat PLA and PDLA1 with unique properties. The products will meet customer needs in a wide range of markets notably packaging, consumer goods, 3D printing and automotive and are specifically optimised for extrusion, thermoforming, injection moulding and fibre spinning and nonwovens processes.

Recycling

At the end of their useful life, the PLA products can be mechanically or chemically recycled, or in some cases composted and returned to the soil as fertilizer.

Total Corbion PLA will leverage on the integration with its plant for lactide (the monomer required for the production of PLA), that has simultaneously been expanded to 100,000 tons per year production capacity. Furthermore, the 1,000 tons per year PLA pilot plant, which has been operational since the end of 2017, is located on the same site and will be used for product development.

The start-up marks a major milestone for both the joint venture and the bioplastics market. With this additional 75,000 tonnes per year facility, the global production of PLA bioplastics will increase by almost 50% to 240,000 tons per year. PLA is a fast-growing polymer market with an estimated annual growth rate of 10-15%.

"The start-up of this state-of-the-art plant establishes Total Corbion PLA as a world-scale PLA bioplastic producer, ideally located to serve growing markets from Asia Pacific to Europe and the Americas," said Stephane Dion, CEO of the company. "The subsequent increase in global PLA capacity will enable manufacturers and brand owners to move into the circular economy and produce biobased products with lower carbon footprints and multiple end of life options."

Ingeo advantage

Having opened its Ingeo PLA plant in Blair' Nebraska, back in 2001, NatureWorks had a considerable head start in bringing products to market and at its 6th Innovation Takes Root conference held in San Diego, California, in September 2018, there was a special session dedicated to the future of performance fibres and nonwovens.

New inventions for Ingeo PLA nonwovens are creating performance attributes unseen before in the field of heath, hygiene and personal care, the company says. Delegates learned, for example, how new hydrophilic technology is creating diapers that reduce diaper rash and create slimmer, more effective absorbent hygiene products. There have also been advances in the multi-compatibility of Ingeo with polypropylene.

Transformational

Bio-based, non-biodegradable plastics, including the drop-in solutions bio-based PE (polyethylene), PET (polyethylene terephthalate) and PA (polyamide), currently make up around 50% or one million tons of the global bioplastics production capacity. The production of bio-based PE is predicted to continue to grow as new capacities are planned to come on line in Europe in the coming years. Plans to increase production capacities for bio-based PET, however, have not been realised at the rate predicted in previous years, according to European Bioplastics.

This, however, may be about to change through what could be a truly transformational technology developed by Canadian start-up Loop.

Coca Cola thinks so, as do Danone, Evian, L'Oreal and Pepsico who are among the major brands who have quickly signed agreements with Loop.

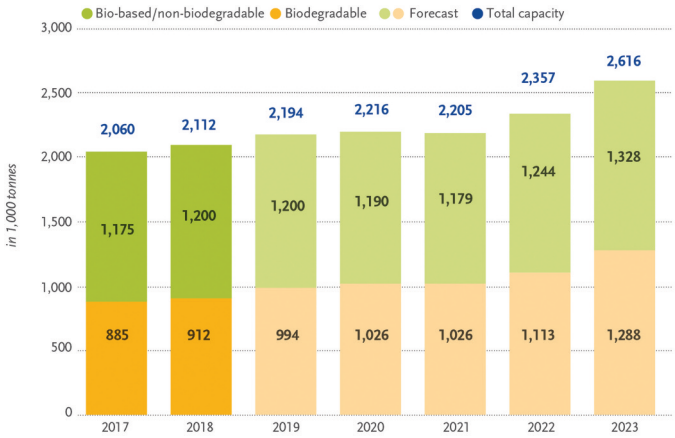
Loop's process allows plastics of no or little value – plastic bottles, packaging and polyester textiles of any colour, transparency or condition, and even plastics retrieved from the oceans that have been degraded by sun and salt – to be diverted, recovered and recycled endlessly into new, virgin-quality PET that even meets FDA requirements for use in food-grade products.

Through Loop's patented zero energy depolymerization technology, the waste plastic and fibres are completely broken down into their constituent monomers – dimethyl terephthalate (DMT) and mono ethylene glycol (MEG). The monomers are then purified, removing all colouring, additives, and organic or inorganic impurities.

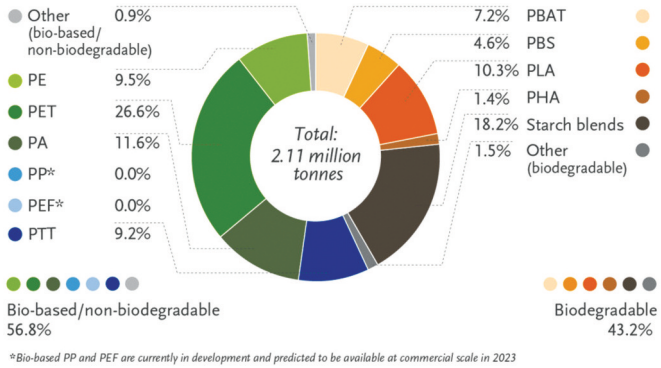
From there, the DMT and MEG components are repolymerized into new PET plastic.

Loop stresses that "down-cycling" is what most often happens in the traditional recycling process, when high quality goods of food-grade plastic are

GLOBAL PRODUCTION CAPACITIES OF BIOPLASTICS

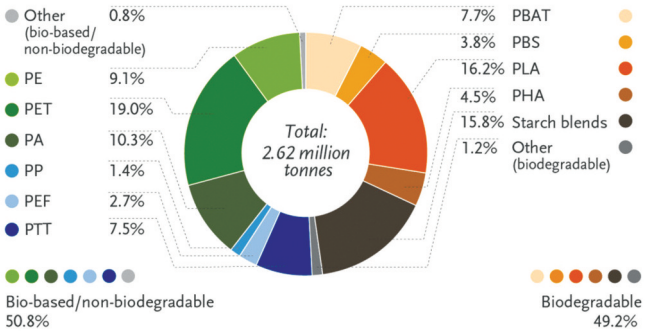


GLOBAL PRODUCTION CAPACITIES OF BIOPLASTICS 2018 (BY MATERIAL TYPE)

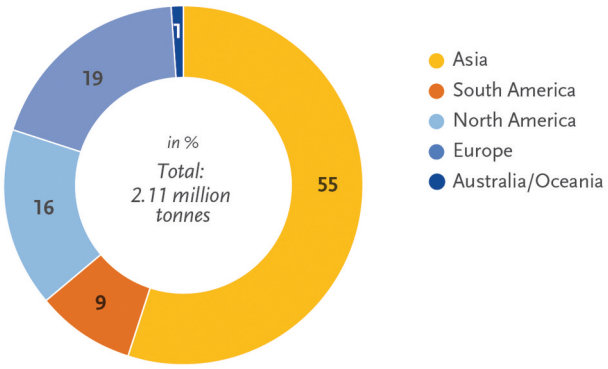


Source: European Bioplastics, nova-Institute (2018).

GLOBAL PRODUCTION CAPACITIES OF BIOPLASTICS 2023 (BY MATERIAL TYPE)



GLOBAL PRODUCTION CAPACITIES OF BIOPLASTICS 2018 (BY REGION)



Source: European Bioplastics, nova-Institute (2018).

transformed into lower quality goods. This reduction in quality prevents recycling efforts from being truly circular, since a surprising amount of waste material still eventually ends up in landfills, and manufacturing from outside the process is required to retain product quality.

By contrast, Loop's de-polymerisation process involves taking low-quality material and transforming it into high-purity PET.

IVL JV

Loop is also currently building a new plant in the USA with Indorama Ventures (IVL).

As one of the biggest, and certainly the most diversified manufacturers of synthetic fibres and fibre feedstocks producers in the world, Thailand-headquartered IVL is now a major player in the nonwovens industry following its acquisition of a controlling stake in Avgol in May 2017. It is also a key fibre supplier to the nonwovens industry through acquired companies including FiberVisions, Trevira and Wellman.

IVL and Loop announced plans for their new plant in last September, in a deal which gives IVL an exclusive worldwide license to use Loop's technology to produce 100% sustainably produced PET resins and polyester fibres.

Commercial production is scheduled to begin at the new JV plant in shortly and IVL says it will be fully subscribed by leading global consumer brands.

PrimaLoft

In another interesting development, New York-headquartered PrimaLoft announced in October last year that it had developed insulation for the outdoor and active sports markets made from a 100% recycled PET with the ability to almost completely biodegrade in 394 days.

PrimaLoft Bio PET microfibre has been developed over the last four years by the company's team of scientists and engineers and despite its highly accelerated rate of biodegradation (compared to the negligible rate of that for standard PET) there is no negative impact on the performance, look or feel of the insulation, the company says.

PrimaLoft Bio fibres break down when exposed to either landfill or the ocean, since they have been enhanced to be more attractive to the naturally-occurring microbes found in these anaerobic environments. The microbes eat away at the fibres at a faster rate, returning the insulation to nature.

The biodegradation process leaves behind water, methane, carbon dioxide and biomass (expired microorganisms and organic waste). PrimaLoft Bio insulation will only biodegrade when exposed to the microbes in landfills or ocean water, remaining highly durable throughout the insulation's usable life cycle in a garment.

To date, PrimaLoft has recycled more than 84.7 million PET bottles from landfills and transformed them into insulation and by 2020, 90% of the company's insulation products will have at least 50% post-consumer recycled (PCR) content.

However, while believing recycling is a good start, the company's president and CEO Mike Joyce has said PrimaLoft is intent on providing an even better answer to the environmental issues facing the textile industry.

Over 80% of discarded textile and garment wastes are still landfilled in the USA, accounting for nearly 8% of the nation's total waste and PrimaLoft believes its advanced biodegradation technology should be of interest to any apparel brand interested in making a smaller environmental footprint, with the potential to transform the outdoor and fashion/lifestyle industries' supply chains.

Trapped air

PrimaLoft PET microfibres trap significant quantities of air, resulting in superior thermal performance and a softer hand feel. They are also said to be more compressible than other fibres and also water repellent, due to a proprietary treatment which reduces the amount of moisture they can absorb, while at the same time changing the characteristics of the fibres so they physically repel water molecules. As a result, the insulation maintains the highest percentage of warmth when wet.

Going a stage further, in November 2018, PrimaLoft announced that its biodegradable fibres had been proven to stand up to the rigorous process of textile manufacturing, while maintaining its ability to degrade. Consequently, it is introducing PrimaLoft Bio performance fabric, billed as the first 100% recycled and biodegradable synthetic fabric.

Both the performance fabric and the insulation material will be appearing in branded products by autumn 2020. **SNW**