

Cracking the problems in rigid plastics recycling

Cross-border and multi-industry initiatives continue to drive progress in rigid packaging recycling – from improvements in processing to designing for recycling. Mark Holmes reports



IMAGE: DAVID ELDRIDGE

Initiatives in rigid plastics packaging recycling from international organisations and cross-industry collaborative ventures are identifying areas of research and development, from which new solutions are emerging. In addition, an increasing number of guidelines are now being established and made available to the packaging industry to ensure that more recyclates are being used and new products are designed for recycling.

Work has continued on a major research and development project in Denmark to develop a robust and flexible reprocessing line for rigid plastics from household waste (see *Plastics Recycling World* September - October 2019). The project involves developing solutions for recycling HDPE, PP and PET. The consortium involves seven Danish sorting plants and research institutions, supported by the Danish Environmental Protection Agency (EPA). Recycling company **Aage Vester-gaard Larsen** (AVL) and the **Danish Technology Institute** (DTI) are the main partners.

The main goal of the project from its outset was to develop new machinery able to recycle challenging plastic streams from private household waste. "The Danish household waste collection varies between municipalities, which makes it interesting to investigate whether the different waste streams have any effect on the final output material," says

Gitte Buk Larsen, Owner, Board Chairman, and Marketing and Business Development Manager of AVL. "In some municipalities the fraction is glass, metals and plastics together, while in some it is only metals and plastics, including or excluding foil and film. One of the main concerns is the metal, glass and plastics fraction, known as MGP. As a result of the project we were able to conclude that by using our new technology the MGP fraction did not have any effect as long as the waste was sorted at a pre-sorting plant with the correct, high technology facilities. However, we did discover problems when there is too much foil in the material stream."

The project had mixed results for PE, PP and PET waste types. "With the PE and PP fractions, we have achieved very good results," adds Franz Cuculiza, CEO at AVL. "However, in regards to the PET fraction the results were not as promising, resulting from multi-length constructions that are the main part of the PET stream. In order to reference this, a number of hand-sorted water bottles were tested that showed much better results. At the beginning the idea had been to develop a new density sorter that was more precise than what we have seen being used so far, but as the project progressed it became clear that it was the washer that would be the solution."

The new washing unit is a batch washer. "It is so

Main image:
Brand owners are increasingly using PCR in new rigid packaging

IMAGE: AVL



Above: The new rigid plastics recycling equipment by AVL

effective that we can wash extremely dirty materials so clean that we are able to extrude the material on a normal single screw extruder with a standard slide plate screenchanger on a 100 micron filter without any problems," says Bo Jakobsen, R&D Manager at AVL. "We have also tested the washer with labelled moulded boxes where the paper content was 25% of the mass and we were able to clean it so well that we could also extrude this material on a normal extruder."

He continues: "The washer is a multi-function washer that can wash in several steps, centrifuge and dry the material to below 0.25% moisture level. We have just completed a test that showed we are now also able to remove odour from household waste in the same unit with a specially developed hot wash. This process has not been documented yet, but we have made internal tests with material using a hot steam wash and normal thermally treated material. The material from the hot wash was the one that performed best. Preliminary migration measurements have shown that we comply within the limit values for packaging of shampoo and soap products, for example."

The positive results with the washer have led to AVL applying for a patent for the invention. "The project as a whole was finished at the end of August 2020 and we have sent the final report to the Danish EPA," says Cuculiza. "When they have officially approved the report, it will become public. We see great potential for this device because it will be able to help recycling companies achieve a higher quality grade product, as well as serve as a potential addition for pre-sorting facilities around the world. A unit like this will be able to be included directly in many washing plants around Europe, without the need to invest in new complete plants to improve quality. We are now looking for potential partners in Europe interested in either buying the patent or selling the technology globally - which of course could be a part of a complete

recycling production line."

Cuculiza continues: "There has been a significant amount of interest in our solution from various parts of the whole value chain. We have also decided to invest and upscale the production line. It will be a factory within the factory and be a closed circuit procedure. Pressed bales will be fed directly into a shredder with the material then undergoing the necessary processes within the closed circuit and only reappearing at the output end. The complete line will be completed and operational by mid-2021."

AVL is seeking expert knowledge regarding the characteristic odours generated from such plants, in order to avoid these and create a better working environment around the facility. The company has also recently introduced a new PCR product range, available with full traceability and data sheets for transparency.

RecyClass, the cross-industry initiative in plastics packaging recycling within Europe, has been active on a number of fronts. It has reported on novel findings for functional barriers in HDPE containers. Analysis of the impact of EVOH on the recyclability of a barrier package is indispensable to advance design for recycling of plastic packaging. Compatibility of the EVOH barrier in HDPE containers with the recycling process has been tested by an independent laboratory. A compatibiliser layer was originally put into the structure, in order to test how an embedded solution could improve the recyclability of a structure usually considered difficult to recycle. The test was performed on natural, five



Left to right: AVL CEO Franz Cuculiza, Danish Minister of Environment Lea Wermelin and Gitte Buk Larsen, Owner, Board Chairman, and Marketing and Business Development Manager of AVL. The minister visited the production line in September 2020, which received national television coverage

IMAGE: AVL



RecyClass

Ongoing Certification for the Traceability of Recycled Content in Plastics

Audit Scheme available

www.recyclclass.eu

IMAGE: RECYCLASS

Above: A Plastics Recycling Traceability Certification Audit Scheme is one of many initiatives being pursued by RecyClass in the EU

layered HDPE containers consisting of 6% EVOH and 3% PE-g-MAH (polyethylene-grafted maleic anhydride) tie layers (by weight) and carried out as per the Recyclability Evaluation Protocol for HDPE Containers. Apart from pre-treatment, tests included extrusion at 220°C and use of pellets in the production of new HDPE containers with a recycled content of up to 25%.

The research shows that when EVOH is sandwiched in the packaging structure with PE-g-MAH tie layers the recyclability is improved. The results of

laboratory tests also demonstrated that the chemistry of these tie layers can enhance the compatibilisation of EVOH and HDPE during the extrusion, avoiding typical yellowing effects and preventing an increase of gels and specks in the pellets. However, this corresponds specifically to the PE-g-MAH tie layers and not to any other arbitrary tie layers. If another type is used, the laboratory tests will have to be repeated. Consequently, these findings will be used to update and enhance the RecyClass Design for Recycling Guidelines for HDPE Natural and Colored Containers, which are one of the pillars serving as a database for the recyclability evaluation within the RecyClass Tool.

The 6% concentration of EVOH and 3% of the PE-g-MAH tie layers (where MAH is less than 0.1%), is therefore reported in the design for recycling guidelines as compatible with the HDPE recycling stream, as no detrimental effects were reported in the testing conditions. However, for an EVOH concentration above 1% with any other types of tie layers it is reported as having no compatibility, as further testing will be required.

RecyClass has also published the Recyclability Evaluation Protocol for Polypropylene as a guidance



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Compatibiliser solution for PE/PP mix

One method for dealing with a mixed polyethylene (PE) and polypropylene (PP) waste stream from packaging waste is compatibilisation. Normally immiscible, PE and PP can be blended by using compatibiliser additives, resulting in a recycled material suitable for durable applications (see feature in *Plastics Recycling World* May-June 2020 issue).

Cyril Coppel, Marketing Manager at compatibiliser company **Imerys**, says: "The current challenge for recycled plastics is to ensure that the mechanical properties of these eco-friendly materials – which tend to deteriorate during the recycling process – are maintained or even enhanced to enable them to meet ever more stringent specifications, fit for additional applications, and remain cost-effective."

Imerys has developed a mineral-based additive called Imerlink, which it says enables "true compatibilisation"

by creating a chemical bond with PE and PP. This results in improved mechanical properties with an optimum stiffness/toughness and the solution is also cost effective, says the company.

The company adds, Imerlink provides thermal stability and improved aesthetics. It says: "Using ImerLink, recycled polyolefins materials that would otherwise not be compatible can now be processed at up to 100% and used in higher value applications that meet key performance requirements."

Imerys says there is a shortage of recycled HDPE with MFI above 2.0 g/10min (2.16kg@190°C). It says: "To try to solve the problem, some recyclers developed a blend of HDPE and PP for their customers, wheelie bin producers. However, sales are limited due to aesthetic issues. Tiger stripes appear on the injected containers due to an unstable melt

flow front that occurs during mould filling. This is caused by insufficient bonding of the molten polymers due to immiscibility. It was clearly demonstrated that the mobile waste container produced with the ImerLink compatibilised formulation demonstrated homogeneous surface appearance and mechanical properties were aligned with the demanding application's requirements."

In extrusion, typically, recycled HDPE is used for twin-wall pipes in this market, says Imerys. "Recycled HDPE is readily available from a variety of post-industrial (old pipes) and post-consumer sources (bottles). Problems occur when PP contamination rates in the rHDPE are above 3-5%. A few companies use virgin HDPE and some use virgin PP. Using ImerLink as a compatibiliser allows recyclers/compounders to use post-consumer wastes that have not been heavily sorted."

for carrying out laboratory analysis of the various design features of rigid packaging made from PP resin. Its ultimate objective is to establish the level of compatibility of a given product with the PP recycling stream. "Recycling of PP containers remains unexploited, advancing its recyclability adds to increasing the potential of this stream and is a long-awaited step that shall be valued if we are to reach the recycling targets," says Werner Kruschitz, Chairman of the RecyClass PP Technical Committee.

The aim of the Protocol is to guarantee recyclability of PP containers, as well as to support innovation in the PP market. It provides a detailed laboratory procedure on how to perform pre-treatment, extrusion and conversion tests. These tests in turn will demonstrate whether the technology or product submitted for approval will have a negative impact on the recycling process.

In addition, RecyClass has established the Recycled Plastics Traceability Certification Audit Scheme for guaranteeing transparency and integrity of claims regarding recycled content in plastics. The Certification's goal is to account for traceability of recycled content in new plastic products which are placed in the EU market. This,

in turn, will allow for a transparent and responsible communication on recycled plastics use. It is based on the international standard on chain of custody, as well as the European standard on plastics traceability. "The Certification will enable a reliable declaration of recycled content, boost consumers' credibility in product's quality, and verify its responsible production," says Gian de Belder, chairman of the Advisory Board of RecyClass.

Traceable content

This Certification adds to EuCertPlast, a traceability scheme for recycling processes. EuCertPlast is the first step of ensuring the quality and origin of recycled material. Recycled Plastics Certification conforms the traceability of recycled content in products throughout the value chain until they are placed on the market. The integrity was verified and approved through several trial audits which took place at converters' and brand owners' sites, including Aqua d'Or in Denmark, Resilux in Belgium, Armando-Alvarez and Klöckner Pentaplast in Spain, and Colpack in Italy. The on-site trial audits were conducted by independent third-party auditors: Aimplas, HTP Cyclos, Sachverständigenbüro

Right: Detergent packaging produced by Greiner Packaging for Henkel now contains 50% r-PP

Mechthild Ahaus and Dott. P.I. Marco Tabani, which accredited that the right systems and tools are in place to trace recycled content during the production process in accordance with the Audit Scheme.

RecyClass has also recognised Recoup, Suez, Circpack, Plastship, Circular Analytics, Aimplas, Veolia PET Germany and Redilo as Certification Bodies to apply the RecyClass method for assessing the recyclability of plastics packaging. Twenty individual auditors within these companies have been granted accreditation to issue RecyClass Recyclability Certifications for plastics packaging. These partnerships will further drive harmonisation of recyclability across the EU.

The **Circumat** project group - comprising Landes-Abfallverwertungsunternehmen LAVU, Transfercenter für Kunststofftechnik (TCKT), Johannes Kepler University Linz (JKU) and industrial partners Erema, Greiner Packaging, Innplast Kunststoffe, Lindner and Borealis with MTM Plastics - is developing technically advanced products made of recyclates to demonstrate new possible areas of application. A pilot project - Recycling Öli - is showing how effective recyclates can be for manufacturing engineered rigid plastic containers.

Öli is a multiple-use bucket for the collection of used cooking oil from households and the catering industry in Germany, Austria and Switzerland, which was previously made of virgin PP. As a result of this cooperation, it is now possible to produce buckets made of 100% recycled PCR rigid plastic with the same properties as the original containers made of virgin material. For example, the bucket has to retain its shape when 400 kg of compression load is applied, has to be heat-resistant up to 80°C and



IMAGE: HENKEL

have consistent dimensions of ± 0.1 mm. Recycling Öli will gradually replace existing Öli buckets.

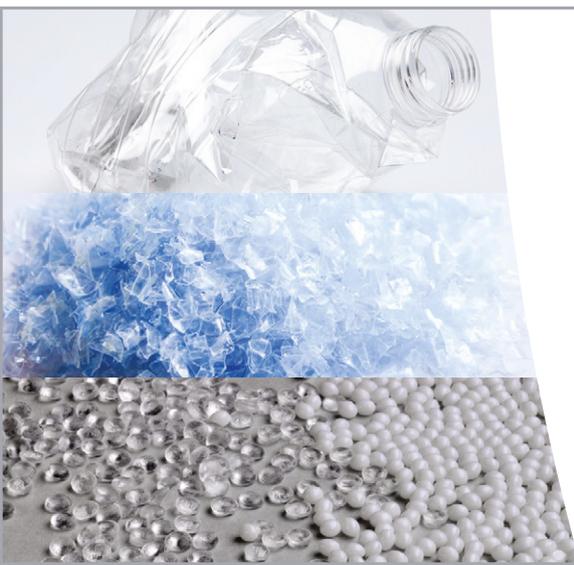
Recycled compounds producer **Interseroh**, and the supplier of EHS and Product Stewardship solutions, **Sphera**, have developed a new online

tool to optimise the sustainability of packaging. With the GaBi Packaging CalculatoR+, companies can now analyse the environmental impact of packaging on a rapid and comprehensive basis - from manufacturing and transport, through to recycling. The GaBi Packaging CalculatoR+ is based on a parameterised model from Sphera, which maps out the life-cycle of packaging and contains a considerable amount of environmental data on materials and manufacturing processes.

Increasing use of PCR

Greiner Packaging has been involved in a number of projects using recycled plastics in rigid packaging. For example, sustainable cardboard-plastic packaging has been produced for Henkel that contains 50% PCR PP for its Persil 4in1 Discs detergent packaging. K3 is designed as a cardboard-plastic combination that combines high quality packaging with appealing marketing communication and a positive environmental contribution. Due to its tear-off system, the cardboard wrap and the plastic container can be easily separated and recycled. Because the two components can be disposed of separately, the packaging is 100% recyclable.

Greiner Packaging uses a two-layer process to create the new design: the inside of the plastic container is made of white virgin material to guarantee a high quality appearance, while the



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Above: The new Infinity Quartz range from Berry Bramlage can be specified in a choice of materials, including PCR plastics

outer layer of the packaging includes rPP from post-consumer sources. This layer's greyish colour has no impact on the look of the packaging, because it is encased by the cardboard sleeve that can be printed for an attractive appearance.

Greiner Packaging has also performed initial tests with K3 yoghurt cups made from 100% recycled polystyrene. The company says that the high levels of purity reached by PS in tests demonstrate its suitability for mechanical recycling. In fact, mechanically recycled PS has 99.9% purity and the potential to achieve food-grade status. Certification of the material is already underway. This pilot project was facilitated by Styrenics Circular Solutions (SCS), the

value chain initiative to realise the circular economy for styrenic polymers. As part of its commitment to sustainability, Greiner Packaging initiated joint activities with SCS with a view to developing food contact applications using recycled PS.

Berry Bramlage has launched a range of premium jars for cosmetic and beauty products to create a strong on-shelf presence and brand image while meeting consumer demands for more sustainable packaging. The new Infinity Quartz range can be specified in a choice of materials (including PCR plastics), finishes and decoration options to meet the widest variety of product characteristics and branding objectives; at the same time, the jars offer the benefits of being refillable or reusable.

The jars are available in 50 ml and 75 ml sizes. The 50 ml jar features Berry Bramlage's Natura Pack removable inner section. This allows consumers to retain the jar and simply replace the empty inner with a new full one, which can be bought separately. The jar is manufactured in PET or PP depending on the requirements of individual products. Both the PET and PP versions have food contact certification, which is particularly appropriate for sensi-



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IMAGE: SPECTRA



Above: A new collection of bath and body products from Land&water is in containers from Spectra that are injection blow moulded in 100% PCR PET

tive or natural ingredients. Caps are produced in the same material as the jars and with the removable PP inner layer, this means the different parts can be easily separated for recycling. Two special versions of the jar are also available, one where the jar is made completely from PCR PET, and a second manufactured in PP incorporating talc. This gives the jars an exceptionally soft-touch finish to provide an enhanced sensory experience for the consumer.

The thick wall construction of the light-weight jars ensures they still project a high-quality appearance on-shelf. For the clear PET jars, the inner section appears suspended within for a strong visual effect. Infinity Quartz jars can be produced in a variety of colours. A wide choice of advanced decoration techniques such as hot stamping, silk-screen, pad and digital printing, lacquering and labelling allows them to be fully personalised for individual products and brands.

Spectra has recently produced recycled packs for Land&water's new collection of bath and body products. Injection blow moulded in 100% PCR

PET, the new packs use Spectra's 250ml Tall Boston Round pack, along with colour matching capabilities for a deep trans blue finish. Spectra adds that its increasing range of HDPE and PET Boston Rounds feature several options for customers to choose from, including standard and flat-based versions in a wide range of capacities from 50ml, up to 500ml options. All Boston Round ranges, along with all other standard designs, are available in biopolymers, as well as PCR.

Neste and **Jokey**, a leading international manufacturer of rigid plastic packaging, are collaborating to develop the market for rigid packaging from recycled materials for food and non-food applications. The companies say that by promoting the use of more sustainable materials in packaging, such as those produced with Neste's drop-in hydrocarbons produced from renewable and recycled raw materials, the partners wish to help other companies using such rigid plastic packaging to meet their materials-related sustainability targets.

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- > www.avl.dk
- > www.dti.dk
- > www.recyclclass.eu
- > www.lindner.com
- > www.interseroh.de
- > www.sphera.com
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