

Making Smart Materials for a Circular Economy in Britain

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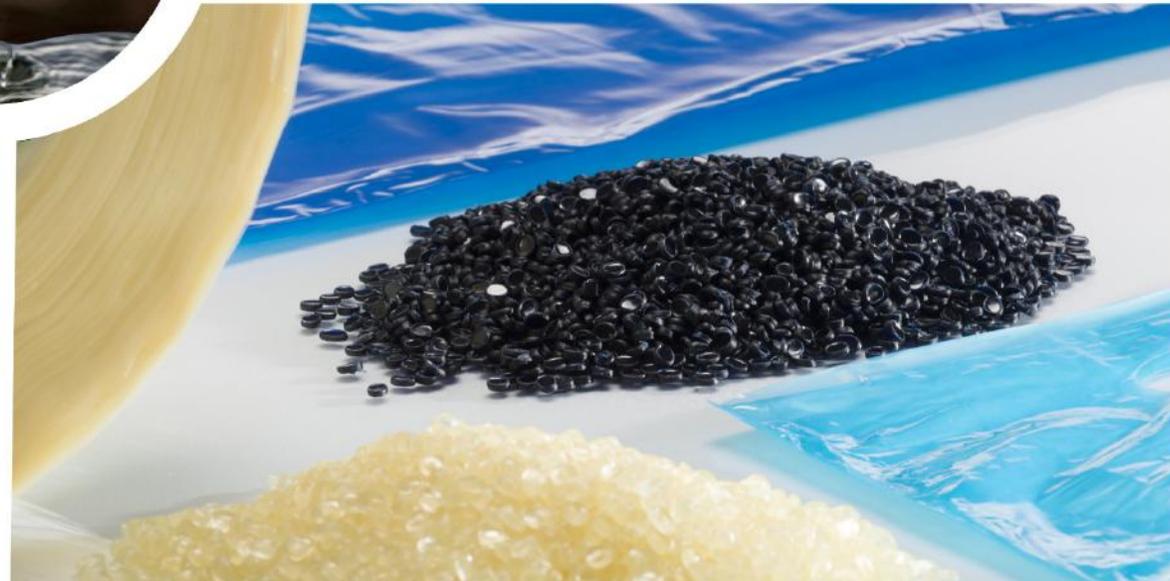
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Aquapak Polymers Ltd





“The best new flexible plastic technology to replace many standard everyday plastics seen for many years”
Plastics Europe, September 2018



Aquapak Polymers – Introduction

- **Half** of all consumer packaging is made of plastic. A **third** of global plastic production goes into packaging end markets.
- Huge **environmental** concern about the effects of plastic waste.
- Aquapak has developed an innovative highly **functional** and **versatile environmental** polymer (Hydropol™), capable of replacing traditional plastics in multiple applications. Few other materials appear able to do this.
- Can be used as a single material or in combination with other single materials to make **all** of the packaging recyclable in standard waste streams.
- Feedstock for polymer **available** at scale, has excellent environmental credentials and is food safe. Marine safe if escapes into the sea.
- Aquapak in final stage consumer trials with major manufacturers and brands for some global market applications. Very strong growth potential.
- Flexible and **scalable** routes to market as Aquapak sells pellets only.
- First manufacturing line ready for **full scale production**.
- Looking for partners to participate in **growth** phase in this dynamic space.

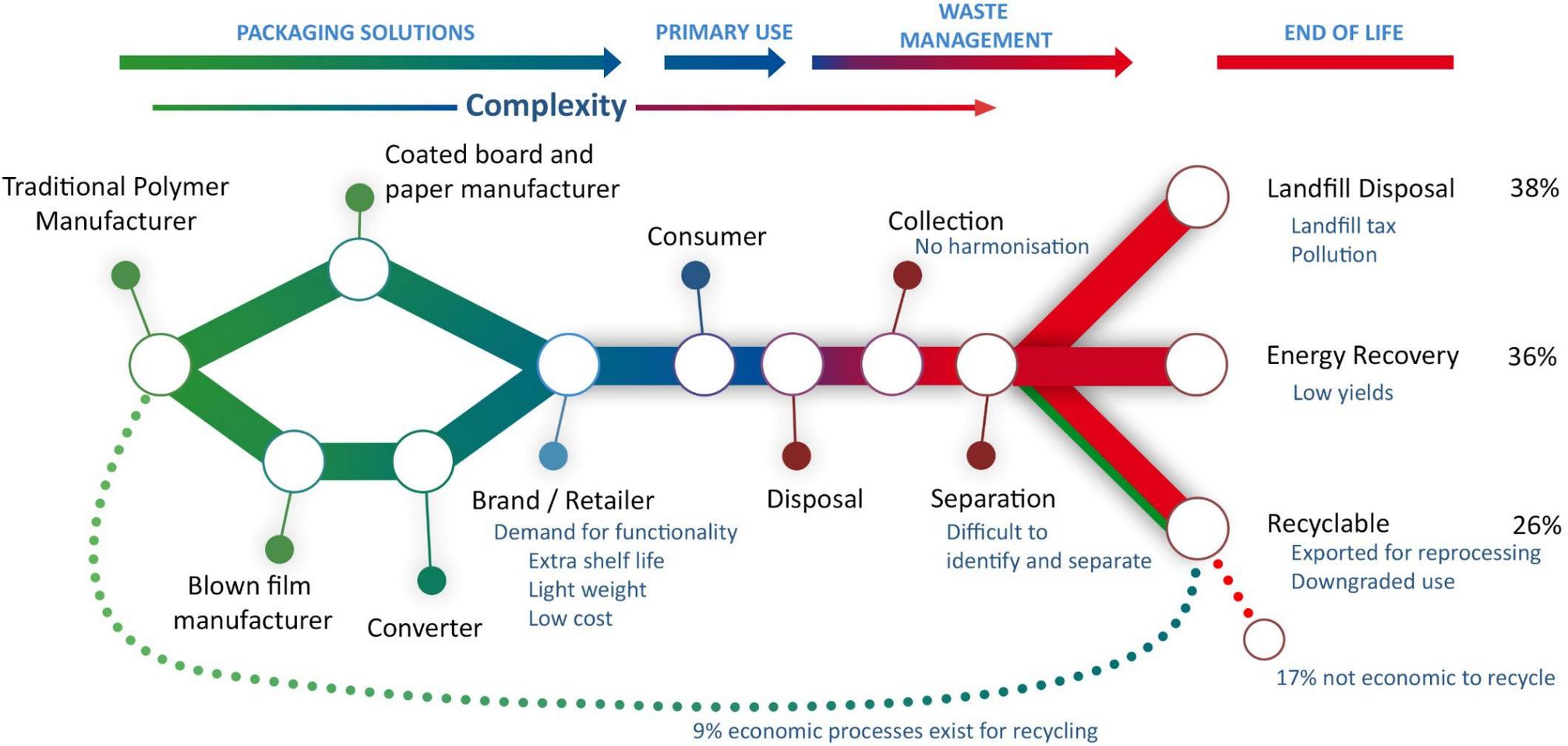
The Plastic Problem

- Recent conflation of number of issues relating to plastic packaging.
- Much packaging has been designed for functionality, but has a single use, with little regard as to how it can be recovered in standard waste streams.
- Most currently available environmental polymers lack functionality and retailers cannot justify increased cost to consumer .
- Many ‘moonshot’ innovative solutions do **not** have cost-effective scalability of feedstock, lack functionality or require special processes to separate and recover in the waste stream, making them **effectively non-recyclable**.
- Disconnect exists between **brands, government** and **waste management** industry and significant misinformation about what can and cannot effectively be recycled. **Actual recycling rates far lower than many believe**.
- Low oil prices have made **recycling uneconomic** vs virgin plastic feedstock.
- Waste management in developed world **fragmented** – many environmental polymers cannot be separated from traditional plastics in waste stream.
- Waste management in developing countries poor – 3bn people have no effective waste disposal

The Plastic Problem – Latest Trends 1

- Focus now on plastic waste globally. UK is leading due to pressure caused by the restrictions / bans on export of plastic waste (eg. to China).
- Media & NGO (Non-Government Organisation) creating awareness of plastics in the oceans but some negative sentiment towards sector.
- Much public confusion over:
 - what is claimed as being ‘recyclable’ and what is actually ‘recycled’ .
 - what a ‘bioplastic’ is. Is it derived from a sustainable source (bio-PE) or does it bio-assimilate harmlessly into the soil?
 - what ‘biodegradability’ means. Is it compostable at home, in industrial composters or anaerobic digestion (AD) facilities? Some or all? Marine safe?
- Due to this confusion many brands and retailers in CSR statements have been claiming that packaging is recyclable where it is **not** cost-effective to do so as the material cannot be recovered and sold economically by the waste management industry.
- Rate of plastic waste material **actually recycled** far below rates claimed as being **recyclable**.
Only 9% of plastics is actually recycled in UK in a Linear Economy.

The Linear Economy



Functionality achieved at expense of End of Life

The Linear Economy Food Packaging – Complexity of Materials

Fresh Meat

- Tray - APET/PE
- Film - 7 layer co-extrusion with PE and Polyamide (PA)
- Label – Paper



Bread

- Film – Clear PE
- Tape – Coloured Polypropylene (PP)
- Tag – Polyvinylchloride (PVC)



Long Life

- All combinations of: PET/Nylon/PE laminate with EVOH barrier/Gas Flush



Fresh Vegetables:

- Film – LDPE
- Shrink – PP
- Punnets – PP + PVC Stretch

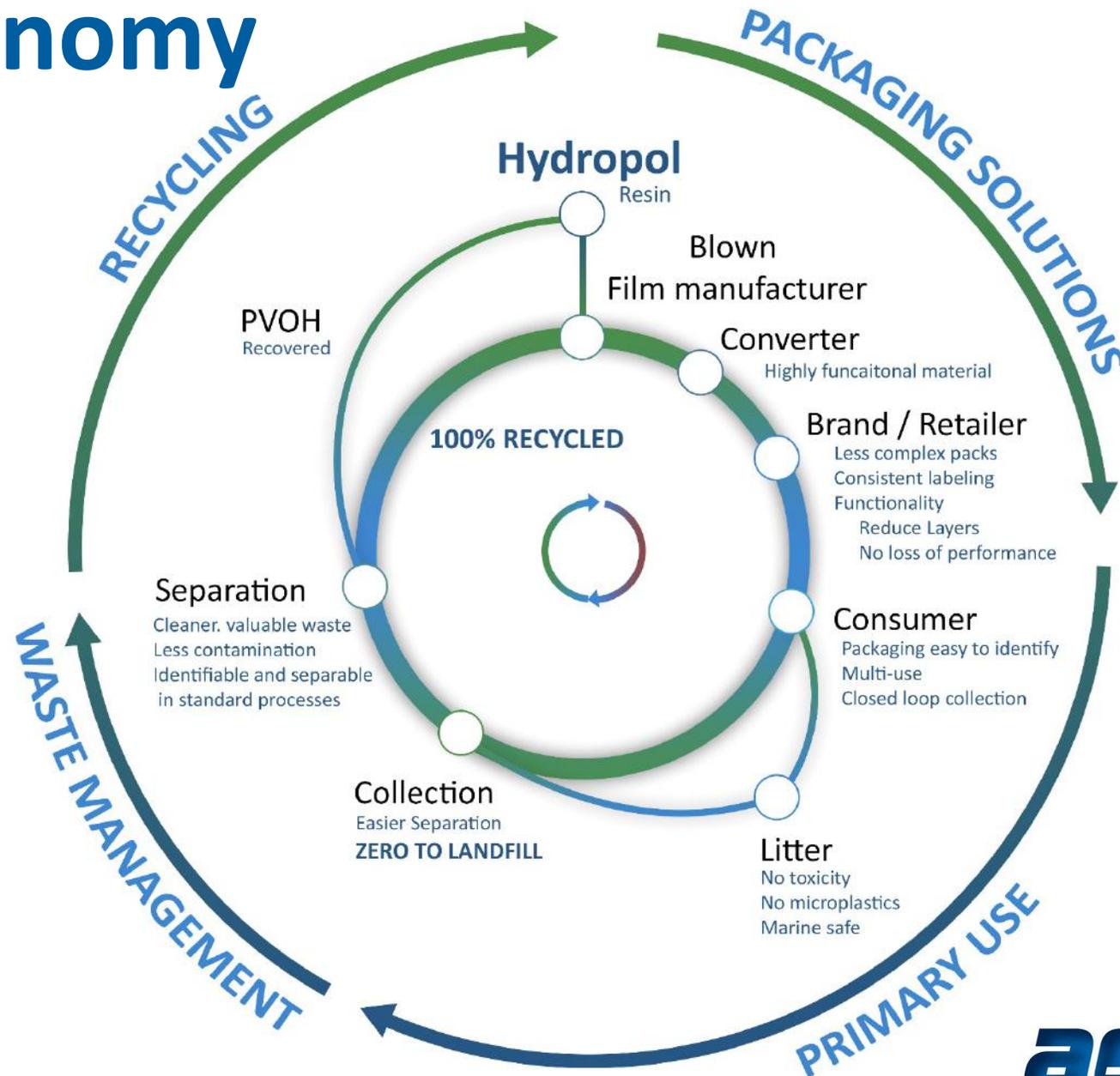


The Plastic Problem – Latest Trends 2

- **Manufacturers (brands)** are increasingly:
 - concerned about public reaction once true rates of material actually recycled are known. Many have now **committed** to high percentage recycling rates and made **bold** statements about moving to environmental plastics over next few years without any clarity as to how to reach their targets.
 - looking to **streamline** range of viable functional polymers that can either be recycled as mono-materials or to find packaging solution where all parts can be easily collected, separated and reprocessed. Traditional polymers **can be recycled** if recycled materials have an **economic value** for waste industry in **excess of costs of collection, sorting and reprocessing**.
 - working in collaboration with each other to attain critical mass for waste industry.
- **UK Government** aims to end avoidable plastic waste by 2042 and hold Manufacturers accountable for environmental impact of packaging.
- **NGOs** promoting **Circular Economy (CE)** initiatives to create a ‘New Plastics Economy’, but **no single new material** has yet emerged to compete with PE and Polypropylene. Therefore big focus on how to make PE packaging and other traditional polymers recyclable (and recycled) rather than wait for new polymers.

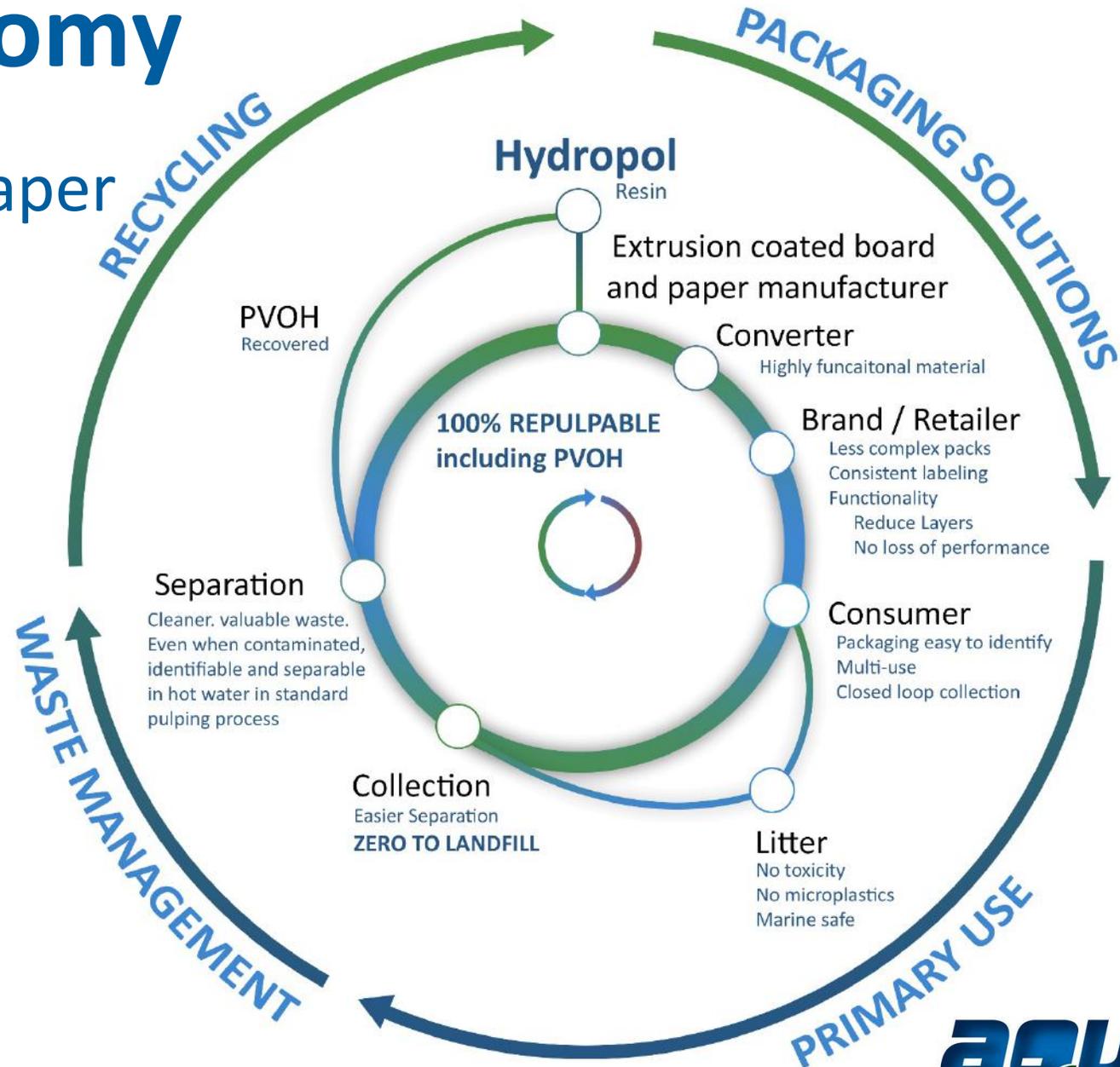
Circular Economy

Blown Film



Circular Economy

Coated Board and Paper



Aquapak's Polymer

Innovative material for the Circular

Economy

- Innovative high quality specially formulated polymer resin, based on one single well-known base polymer – **polyvinylalcohol (PVOH)**
- Formulated PVOH resin, registered as Hydropol™, produced in **pellet** form that is ready to be used in **any thermoplastic process**.
- Capable of running on most **existing plastic processing equipment**. Minimal capital expenditure for producers.
- Materials developed are **functional** and **highly versatile**. Can be used in applications as a **single material** or **in combination with other materials** that make **all** of the packaging recoverable and recyclable.
- All materials used have **excellent environmental credentials** and are **food safe**.
- PVOH has been tested and is **non-toxic** to marine species. Also hydrophilic, so does **not attract harmful toxins in the ocean** or form **microplastics**. Breaks down and harmlessly turns to biomass in soil and sea.
- Aquapak material **is capable of being processed and in all standard waste streams** without major investment by the Waste Management companies.
- **Circular Economy** solutions possible for many current 'single use' items – food pouches, sandwich boxes all become fully recyclable.

Aquapak's Polymer – HydroPol™

Highly Versatile Material

Special Aquapak formulation **HydroPol™** has made polymer suitable for:

- **Blown film extrusion** for use as:
 - single barrier layer
 - laminating onto paperboard
 - laminating or co-extruding with polyethylene (PE) or other traditional plastics
 - Laminating or co-extruding with other biopolymers (PLA, cellulose).
- **Extrusion coating** onto:
 - paper or paperboard
 - other biopolymers.
- **Blending** with other biopolymers to form completely new bio-materials.
- **Injection moulding** and **thermoforming**.
- Applications requiring a **formulated** PVOH pellet rather than flake.

HydroPol™ - Functionality

- **High bi-axial strength** and **puncture resistance** (approximately two and a half times as strong as high density PE film by equivalent weight)
- **Solvent, petrochemical, grease and oil barrier**
- **Oxygen barrier** (equivalent to EVOH)
- **U/V resistance**
- **Clear film with excellent anti-static properties**
- **Water soluble.** HydroPol can be formulated to be soluble at a desired temperature - ambient (30 degC), intermediate or high (>70 degC)
- Capable of significantly **extending the shelf life** of certain foods due to its barrier properties and hydrophilic nature.
- Capable of being **printed on directly**, excluding the need for 'corona' treatment and good for heat sealing
- **Laminates or co-extrudes** with other polymers reducing need for multi-layer films and tie-layers.

HydroPol™ Applications 2

As a single (mono) film

- Luxury garments
- Sharp objects
- Anti-static bags
- Bulk-food AD bags
- Environmental clean up
- Dog poo bags (AD)



Extrusion Coated paperboard (and window film)

- Sandwich boxes
- Food wraps



Anti-infection barrier (mono film)

- Laundry bags
- Cytotoxic bags
- Aprons
- Gloves



Complex food packaging - laminates

- Dried Pet foods
- Cooked meats
- Fresh vegetables
- Crisps
- Cheese



End of Life 1 – Packaging and the Circular Economy

- Packaging particularly targeted in CE
- **Historic** trade off in traditional plastics between:
 - continual need to improve functionality in primary life
 - meaningful and economically feasible ways of dealing with it after primary use.
- Innovations in identification and sorting in waste streams **limited** due to:
 - **complexity** of materials
 - **lack of coordinated approach** to waste collection on national and regional basis
- **Awareness** now that new materials are the key which:
 - are based around **single materials**
 - **if multiple materials** are required, should be **easily identifiable and separable** in standard processes
 - can **all be recycled**
 - if they cannot be recycled they should achieve **biodegradation in all modern waste disposal systems** (industrial composting and AD)

End of Life 2 – HydroPol™ Environmentally Safe

- Environmental claims of HydroPol™ depend on **form factor of final product**, after it has been processed by manufacturer.
- Legislation applies to final form factor (film, tray, lid) rather than to pellets.
- PVOH base resin **well established** as being **inherently safe and non toxic** in the environment. Used in detergent pouches in dishwashers, to coat paper, in surgical stiches and to encapsulate pharmaceuticals. Breaks down harmlessly into biomass, CO2 and water and the fragments ‘bioassimilate’.
- In the sea will sink (density of 1.2), soften and break down completely over time. Duration depends on thickness, temperature and solubility of PVOH blend.
- Toxicity tests show that it is **marine safe** to all regulated test fauna.
- External programme of tests and trials on HydroPol™ to verify claims on:
 - marine biodegradation of (OWS & Vincotte/TNO, Belgium). Pre-testing indicates compliance
 - material performance. Field trials with BIFFA, Veolia, Loughborough and Southampton University for various form factors.

End of Life 3 – HydroPol™ Fully Recyclable

- **Single materials**

- Hot water solubility (>70 degC) allows easy separation of HydroPol™ and recovery from the general waste stream. Hot water present in most standard waste management processing facilities.
- Infrared (IR) signature allows identification of PVOH film

- **Coated paper**

- Hot water solubility allow specific recycling in some special waste streams, such as paperboard re-pulping. Can be hot washed out and HydroPol™ recovered or HydroPol™ left in the dissolved pulp. In papermills PVOH already present in coated paper and acts as binding agent in the re-pulping process.

- **Standard flexible plastic laminates**

- If multi-layer laminates can be designed, using the natural functionality and properties as an adhesive, to be made of two materials only, with HydroPol™ as one layer, hot water solubility allows HydroPol™ to be separated and the other material recycled. Potential to work with traditional recyclable plastics (PE, PET) and compostables (cellulose, Polylactic acid (PLA)).

End of Life 4 – HydroPol™ Biodegradable

- Not principle focus of Aquapak as CE approach requires recyclability, but important if uncontrolled leeching of HydroPol™ into the environment. Regulatory standards (see Appendix) important but under much scrutiny.
- Many **traditional plastics**:
 - are **hydrophobic** and therefore attract toxins and pesticides causing long term affects on flora and fauna
 - **fragment to harmful microplastic residues** (well publicised in daily news)
- PVOH base resin **well established** in scientific literature to be inherently **biodegradable** in **waste water, Anaerobic Digestion (AD)** and **Industrial Composting**. The degree depends on blend of PVOH, and form and gauge of final product but typically film would be less than 15 microns.
- **AD** is especially important as starch based compostables must be removed from AD systems. HydroPol™ is not harmful to the microbes and thus biological waste can be introduced directly into AD without de-bagging.

Aquapak Formulation Facility in UK

- Formulation process for the manufacture of proprietary pellets developed with major German technology partner and equipment manufacturer. Initial formulations ready and new formulations being developed to meet specific application requirements.
- UK formulation facility built and capable of full scale commercial production on first manufacturing line. Initial ISO accreditation achieved Aug 18.
- Consumer trials in process with anticipation of first regular orders over coming months.
- Initial capacity 6,000MT pa but capacity planned to reach 30,000MT pa by mid 2021. Capable of significant acceleration if required.



R&D at Aquapak

- Strong internal R&D Group working in partnership renowned polymer experts in academia.
- Specific expertise in polymer chemistry, reaction process engineering and mechanical engineering. Worked with most biopolymers – especially cellulose and PLA.
- Pilot lines for compounding / pelletising, blown film and extrusion coating.
- Chemistry lab for QC under development.
- External Co-development partnerships with customers to produce new materials and packaging solutions. Customers to perform R&D with support from Aquapak with pellets, technology transfer and expertise.
- Looking to share new IP and create a portfolio of new products.

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