Chemical Recycling PET

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Reaction mechanisms

Hydrolysis

Adding H2O to the polymer

Results in PTA and MEG

Also called saponification

Glycolysis

Adding MEG to the polymer

Results in BHET

Can be followed by adding H20 and making PTA/MEG

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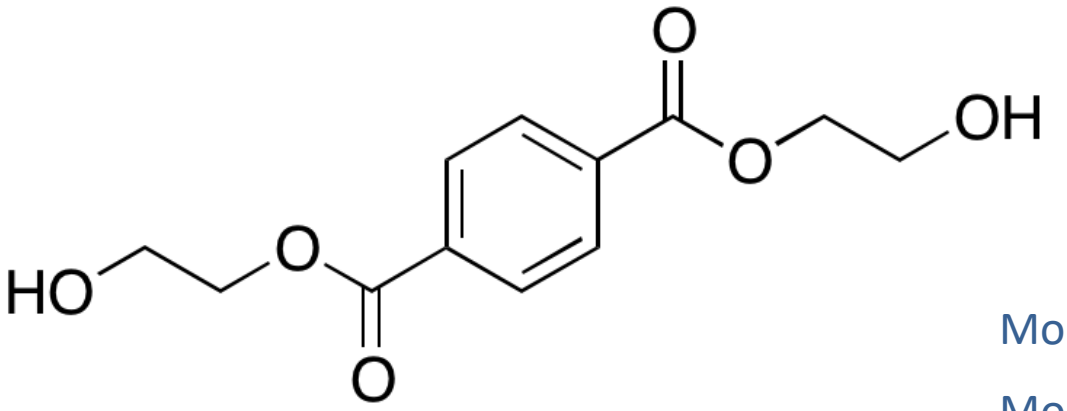
BHET

Bis(2-Hydroxyethyl) terephthalate



Molecular Formula: $C_{12}H_{14}O_6$

Molecular Weight: 254.24 g/mol

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Important Process Steps

- Feedstock preparation
  - Sorting
  - grinding
  - washing
- De-polymerization (Technology/Temp/Time/Cat)
- Separation contaminants
- Purification, removal colorants
- Crystallization BHET/PTA
- Drying to free flowing powder

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Main Developing Companies

Company	Specifics	Product
Carbios	Fermentation	PTA / MEG
Garbo	n-Purification steps	BHET
Gr3n	Microwave reactor	PTA / MEG
Ioniqa	Ionic liquids	BHET
LOOP	Filtration/crystallization	PTA / MEG

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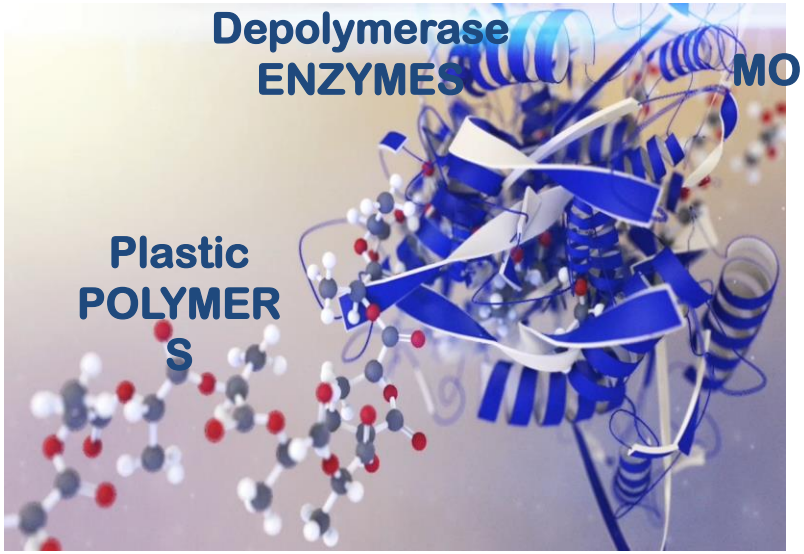
The radical innovation of Carbios : enzymes to break down plastics !



REGENERATION OF VIRGIN PET
FOR ALL PET APPLICATIONS

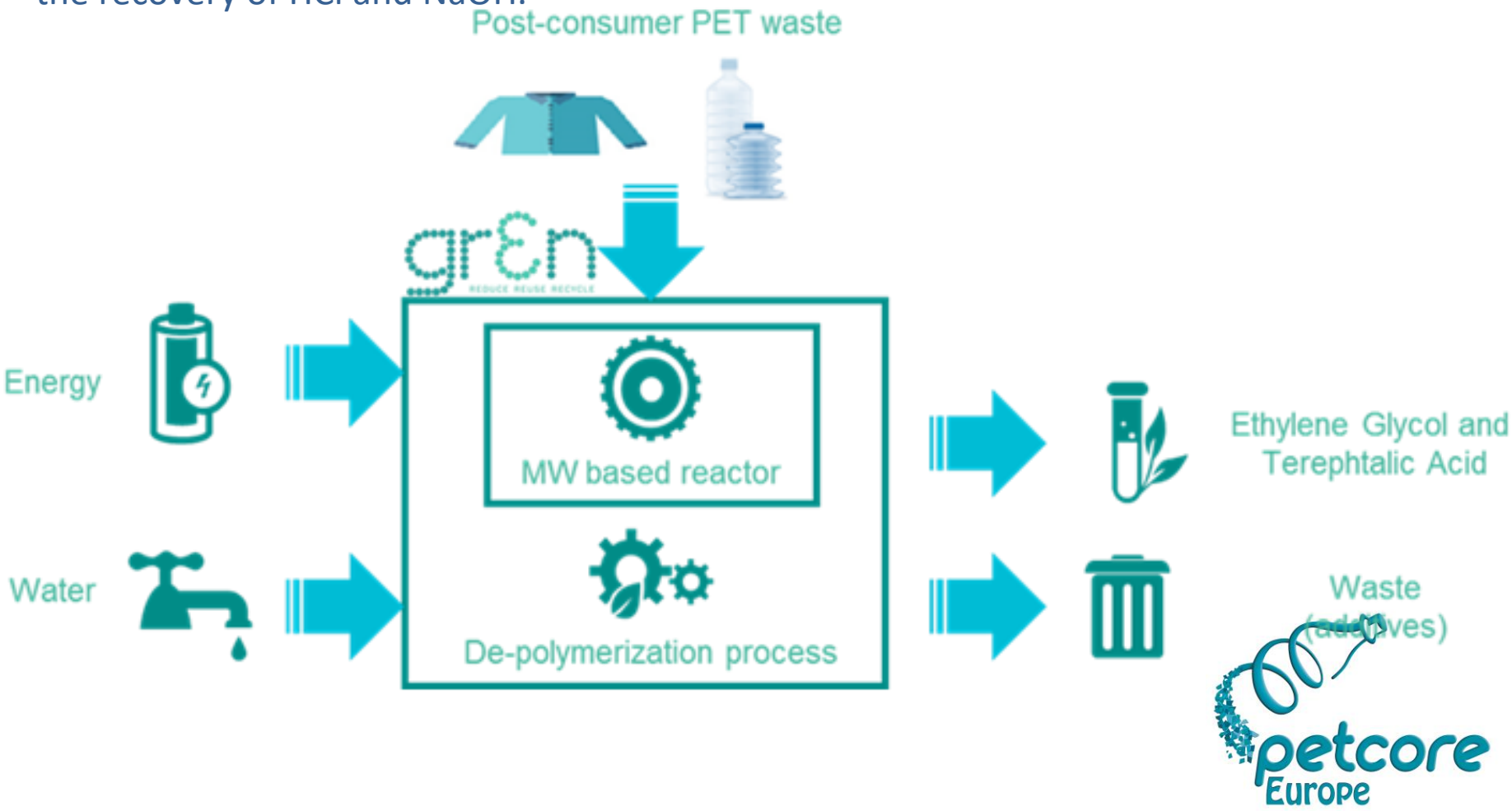
NON RECYCLABLE PET
COLORED, OPAQUE, COMPLEX, MULTI-LAYERS

Advantages of the enzymatic process:

- 100% Recycling
- Enzyme selectivity: no need of sophisticated sortin
- Recycling of complex plastics (PET/PE; PET/PA)
- Low consumption of energy

Gr3n process

RPET-flakes are treated with a caustic ethylene glycol solution in a microwave heated de-polymerization unit. The solution of PTA and PTA salts are then filtered and the filtrate is distilled to recover the EG. The distillate bottoms are treated with HCl to precipitate the PTA (which is washed and dried). An electrolysis process is present for the recovery of HCl and NaOH.



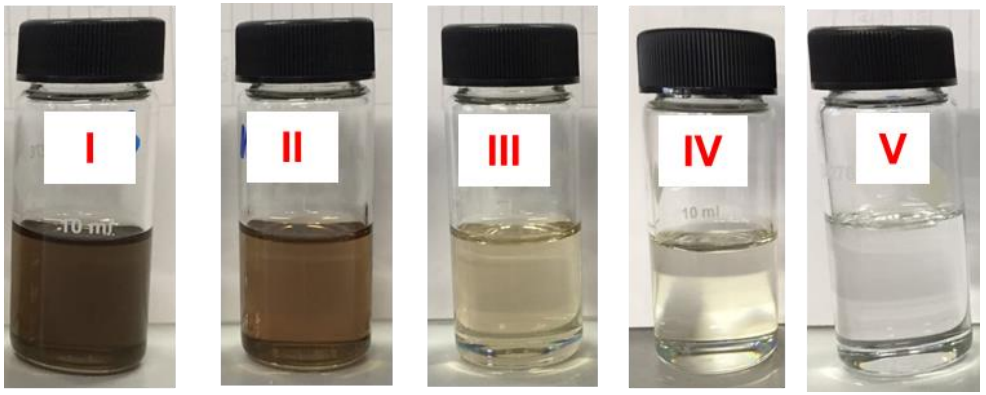
GARBO purification process

De-polymerization of PET waste to monomer BHET via proprietary glycolysis and several purification steps for removal of solids, other polymers, salts, color and other contaminants.

Waste PET

EG

5 Purification Steps



PET Bottle

Purified BHET crystal

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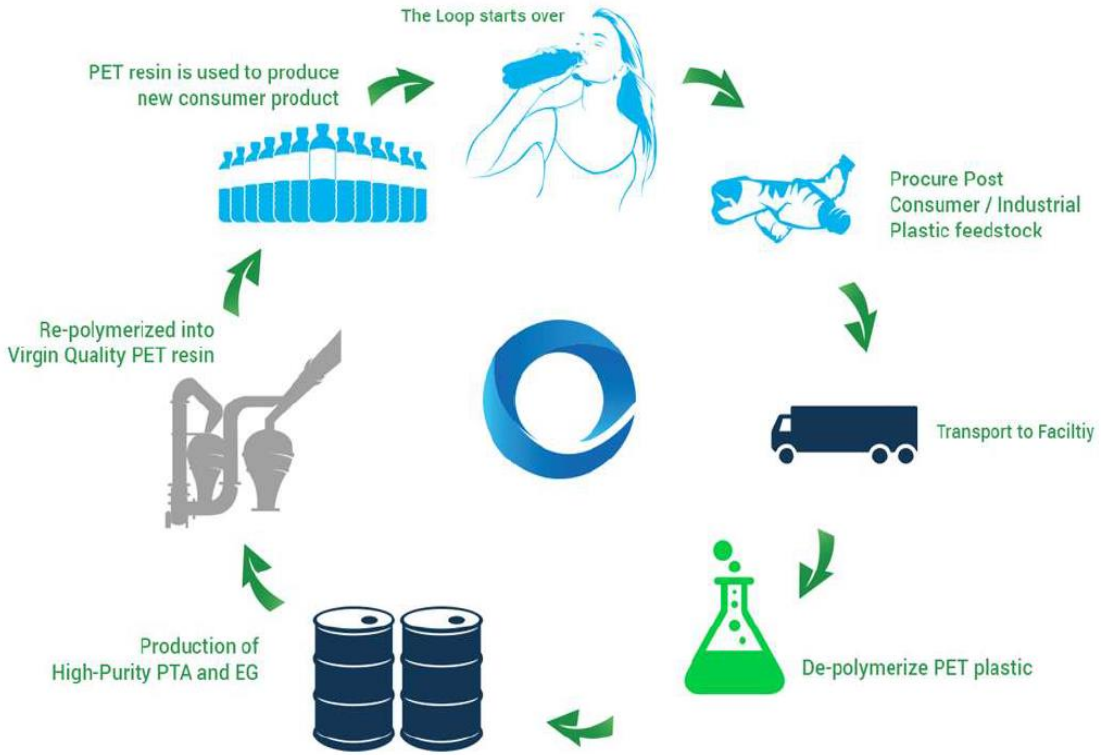
Loop Industries

- Technology is focused on the depolymerization of PET waste streams into PTA and MEG at ambient temperature and pressure in combination with readily available chemicals



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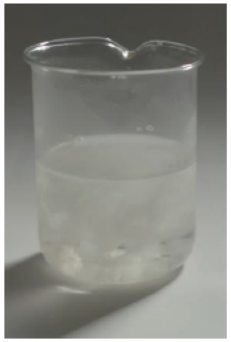
Ioniqa Technologies

The use of ionic liquids as the solvent and/or catalyst for the glycolysis of polyester into BHET. This includes the use of (recyclable) magnetic ionic liquids for the separation step (magnetic decanter).

Step 1: Collection of several PET materials

Step 2: Addition of Magnetic Fluid to PET materials and heating

Step 3: Magnetic separation of the Magnetic Fluid: addition of water, magnetic sedimentation and decanting of supernatant



Step 4: Crystallisation of clean PET monomers (BHET)

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Summary and conclusion

- Chemical recycling is complementary to mechanical recycling
- They will recycle PET Thermoforms
- All processes are in development stage
- All will depolymerize PET at a certain cost and quality of resulting monomers
- No need to have a clear winner
- Problems is the cost of the chemical recycling in combination with the cost of the feedstock and feedstock preparation.
- Problem is finding the right partner and finding the money for scaling-up

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