



Total Plastic Recycling – Hydrocarbons and Beyond Contributions to the Circular Economy



CHEMICAL ENGINEERING PHD

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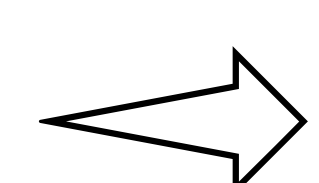
OBJECTIVES

Develop methods to recover metals and hydrocarbons from complex recycling waste streams containing plastics, with a focus on biaxially oriented polypropylene (BOPP).

INTRODUCTION

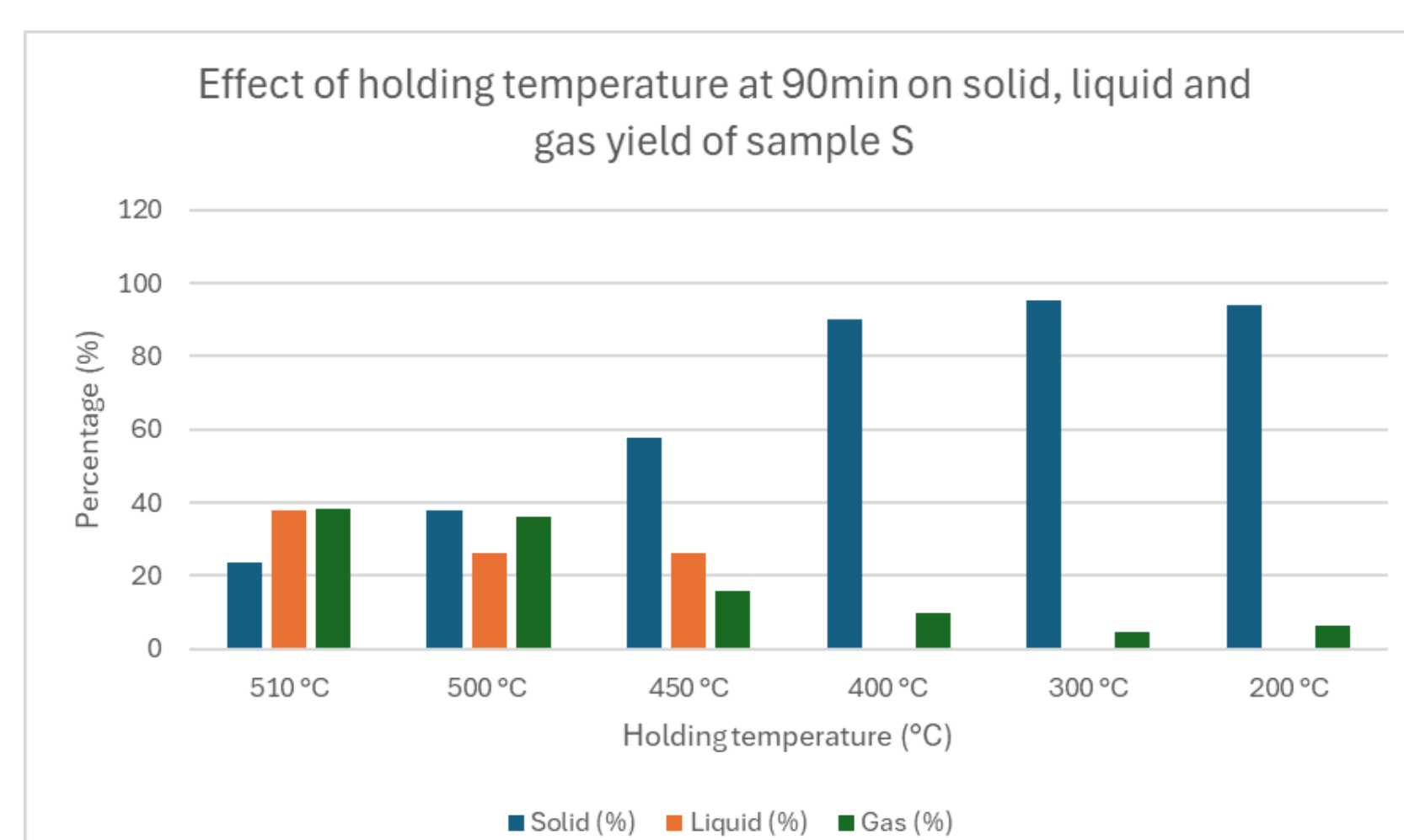
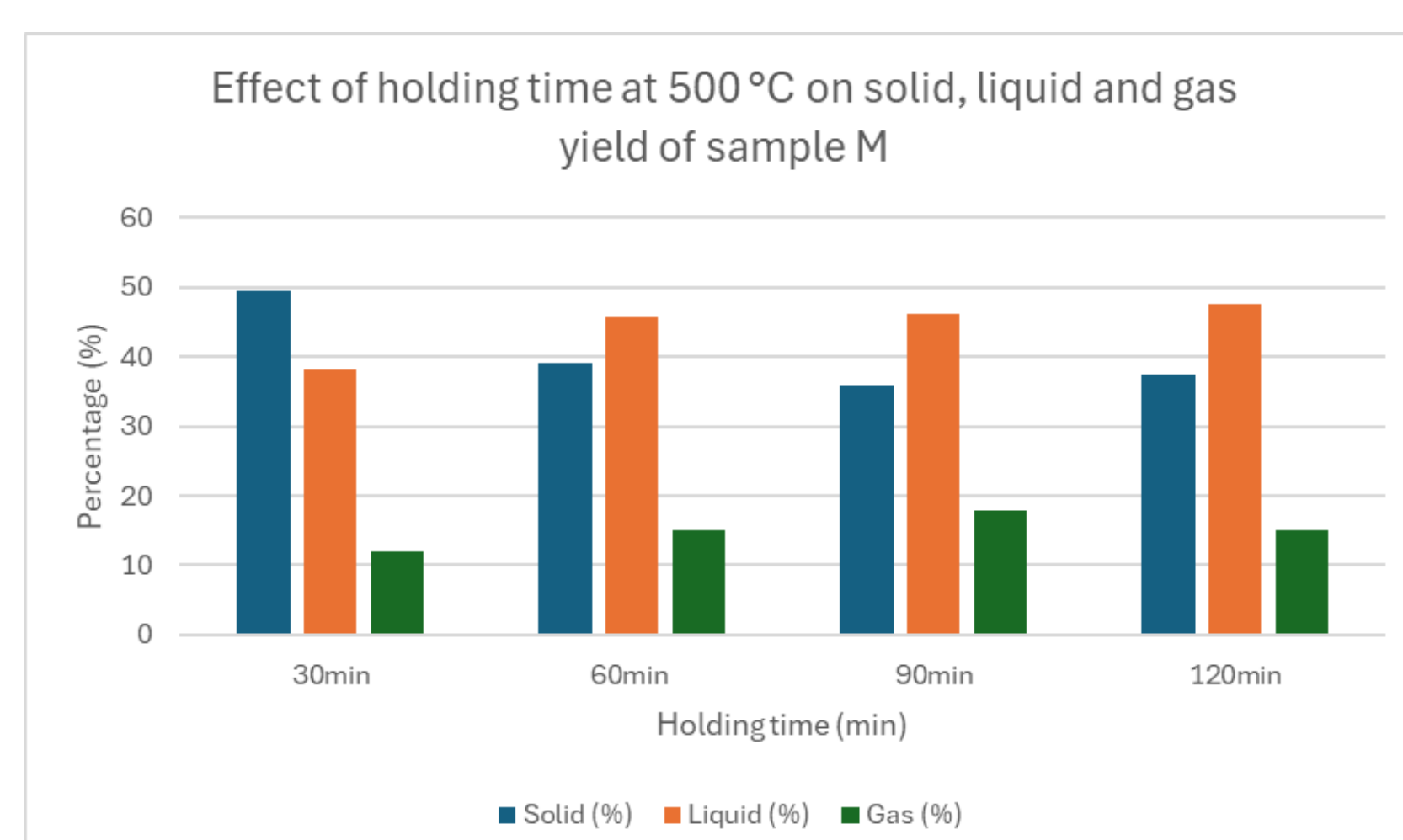
BOPP is widely used in food packaging and is produced by stretching the polymer, both longitudinally and transversely, aligning molecular chains in two directions, followed by a vacuum coating process of SiO_x and/or AlO_x. Its excellent barrier and durability properties make it valuable, but its multi-layered composition poses significant environmental challenges due to the difficulties in its mechanical recycling. Advanced recycling techniques, such as pyrolysis and chemical recycling, offer promising solutions to convert BOPP waste into reusable raw materials, overcoming traditional recycling limitations and reducing environmental impact.

METODOLOGY



HYBRID REACTIVE
DESTILLATION (HyRD)
Lab-scale reactor

Sample S = Wrapper for chocolate-covered biscuits
Sample MK = Wrapper for chocolate bar



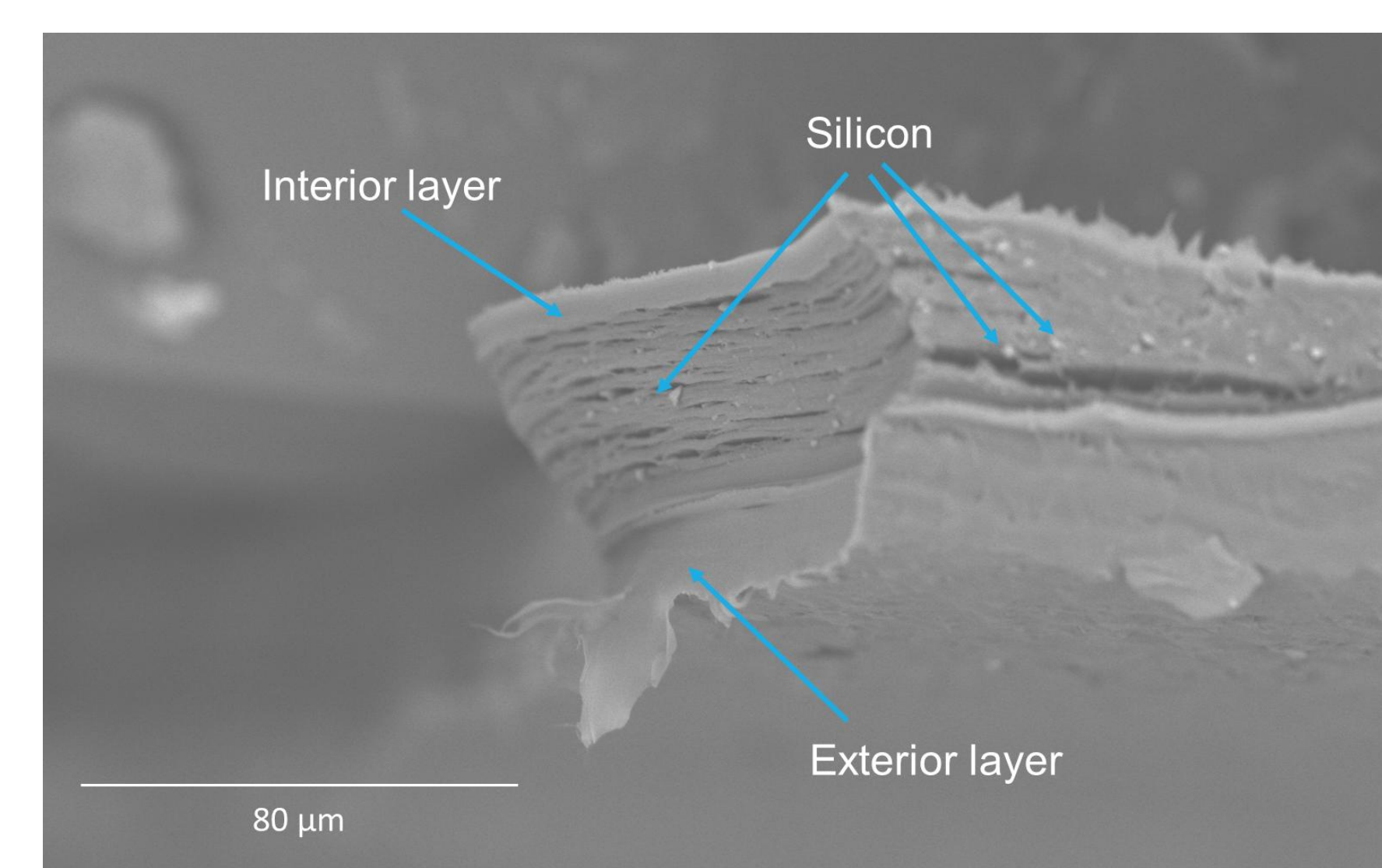
BOPP example

Chocolate wrap

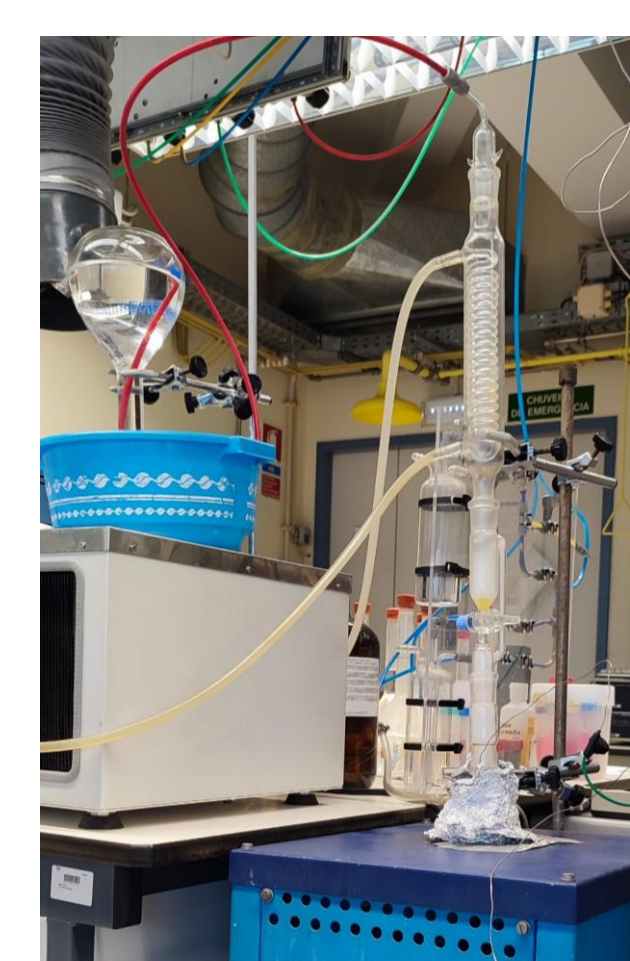


- ✓ Polypropylene plastic packaging
- ✗ Cannot be recycled
Instructions to dispose in trash

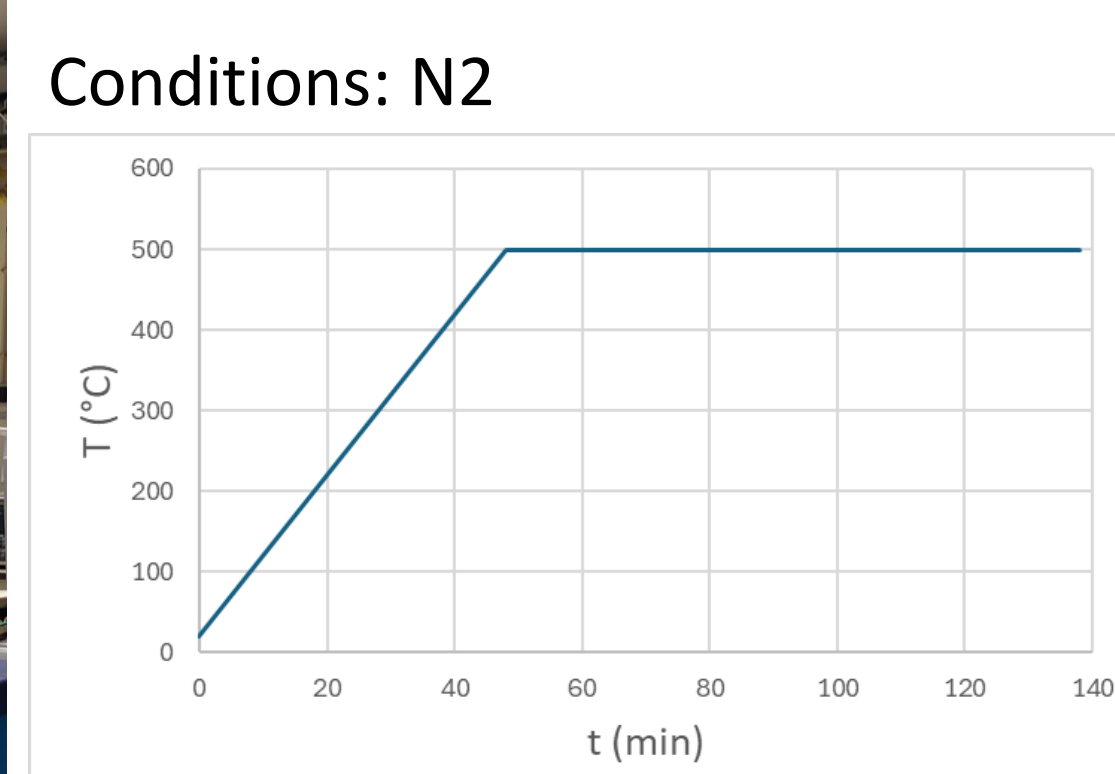
BOPP with silicon oxide



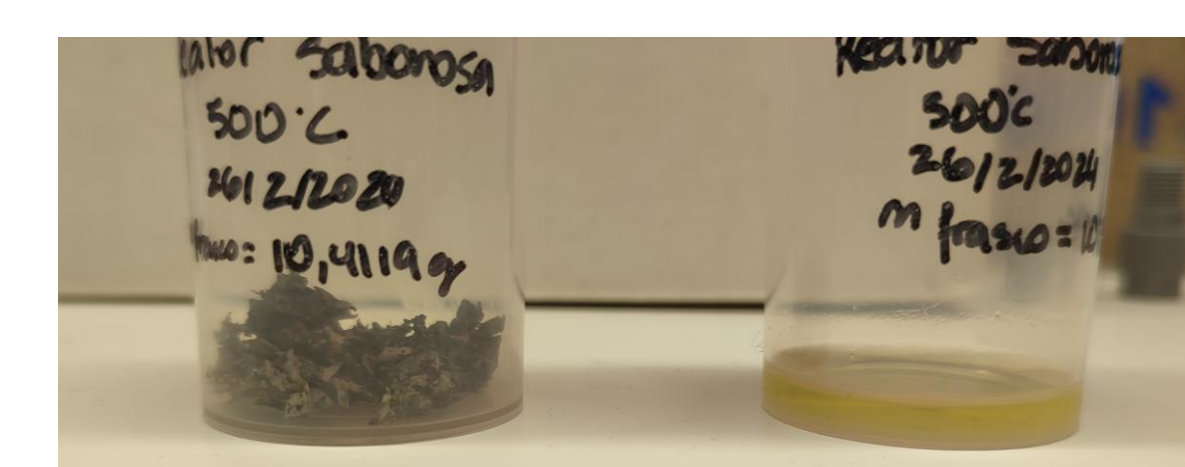
SEM image of sample MK.



Setup of the lab-scale reactor. Adapted from Santos (2018).

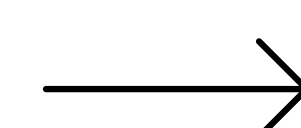


See degradation happening
in real time



Goal:

Liquid + Gas



CONCLUSIONS

- About 10% of the reactor's solid residue consists of an inorganic component.
- GC analysis of the reactor's liquid and gaseous residues shows both are composed of hydrocarbons.
- The gas phase contains hydrocarbons between C₂ and C₆, while approximately 80% of the liquid phase consists of hydrocarbons between C₅ and C₁₀ in both samples.
- The best outcome for the HyRD was 500 °C holding T and 90 min holding time.
- Pyrolysis is a promising technique for recycling BOPP plastics.

REFERENCE

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- [2] Breil, J. (2016). Oriented Film Technology. *Elsevier eBooks*, [online] pp.153–172. <https://doi.org/10.1016/b978-0-323-37100-1.00012-0>.
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- [4] Santos, E.R.F. Nanostructure Materials as Catalysts for the Degradation of Polyolefins. Ph.D. Thesis, Instituto Superior Técnico–University of Lisbon, Lisbon, Portugal, 2018.



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