Liquid and gas products from lead acid battery (lab) derived plastics via pyrolysis: a techno-economic assessment to maximize the value

Western Engineering

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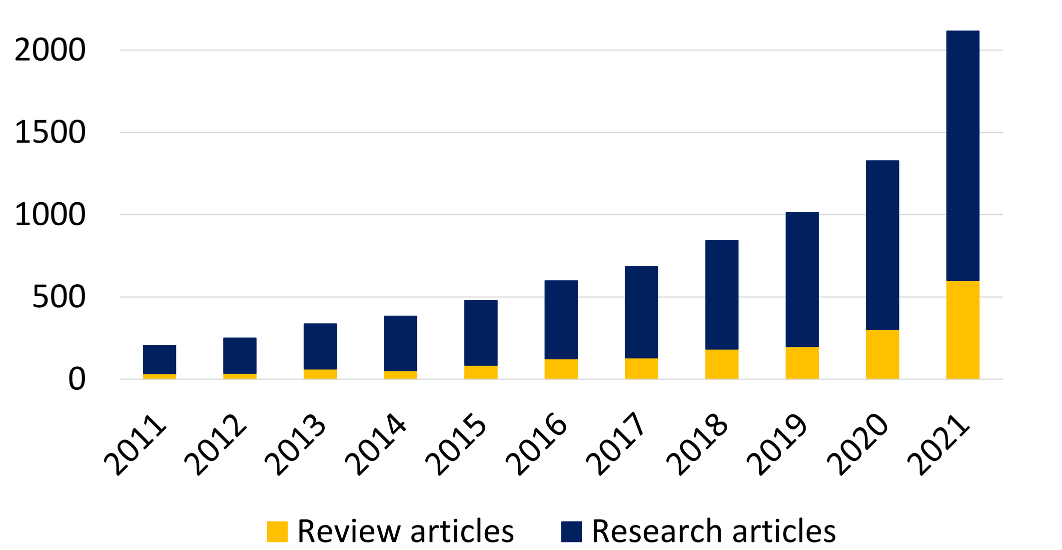
Maddalena Laghezza, Franco Berruti, Silvia Fiore

Motivation and Background

Lead acid batteries (LAB) are efficient, safe and low-cost. Their **market** was valued at **37.5 billion $** in Europe alone in 2020. The main application in the automotive sector is starting, lighting and ignition (75%). **Polymeric materials** account for **22-30%** of the whole end-of-life battery and hold great value.

The research interest in plastic waste pyrolysis has more than doubled in the last three years. The main focus is virgin plastics treatment at the laboratory scale.



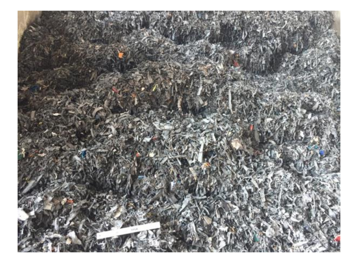
For this reason, our research focuses on real industrial plastic waste. To identify the impacts of contamination on yields and product composition. Moreover, process and plant scale-up are carried out to achieve industrial implementation of plastic waste pyrolysis.

Objectives

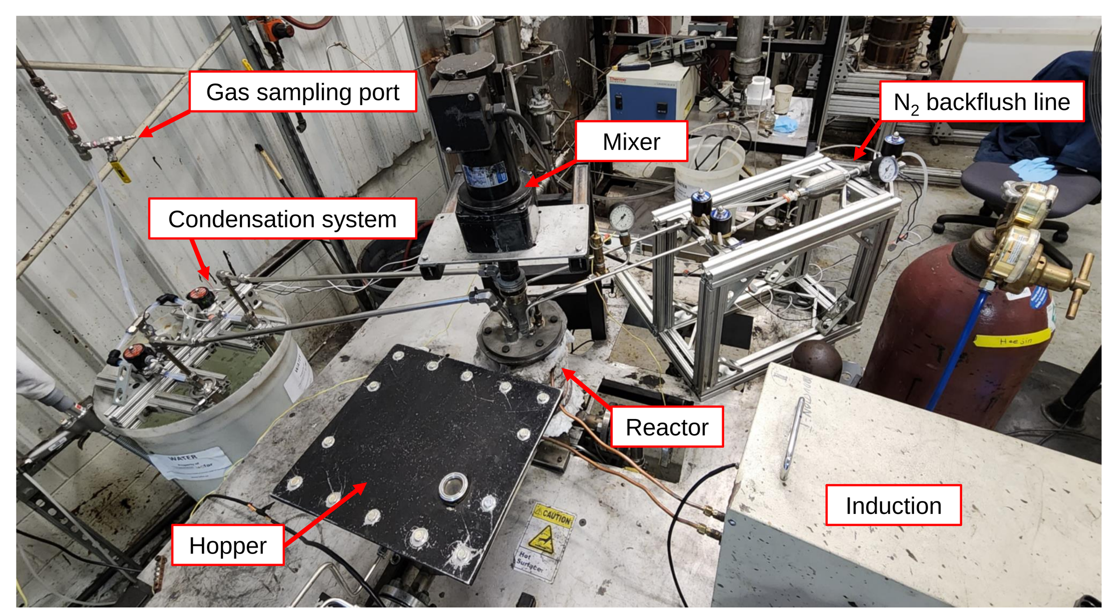
- Assess liquid and gas production for LAB-derived plastics pyrolysis with different operating conditions in a laboratory-scale rector;
- Perform a techno-economic evaluation of the pyrolysis of this feedstock and to assess the economic sustainability of the scale-up of the considered process;
- Compare the investigated processes and products and define the most advantageous configuration.

Methodology

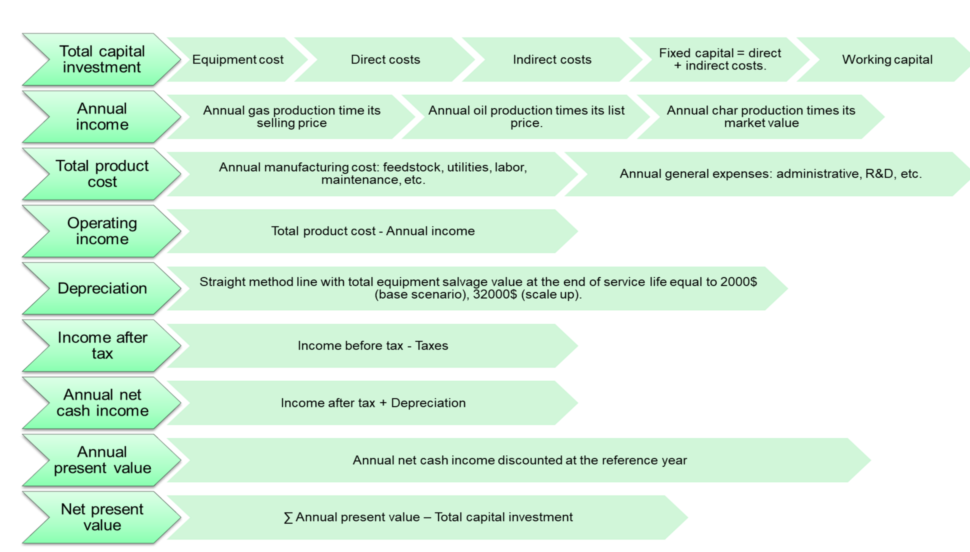
- Lead acid battery-derived plastics were provided by **Rovereta s.r.l**



- **Single-stage pyrolysis** in mechanically fluidized bed reactor (**MFR**), feeding rate of 0.90 kg h^{-1}, temperature 550-650°C, nitrogen flow 1 L min^{-1}



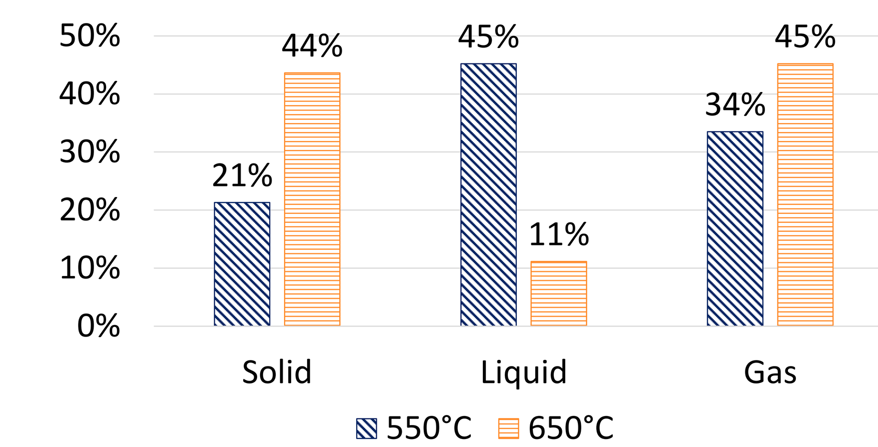
- **Techno-economic analysis** development method



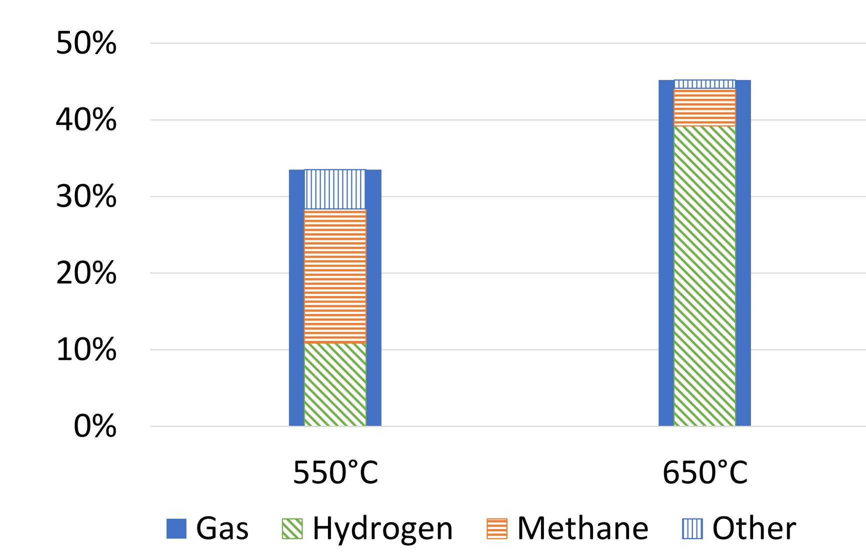
- Plant scale-up to treat 3,000 tons per year of LAB plastic.
- Top-down analysis to define the minimum plant size required for the process to be industrially realized.
- The scale-up scenarios consider the economic parameters as in the base scenario and the influence of different energy sources (electricity, natural gas, methane recycle).

Results

- Yields



- Gas Composition



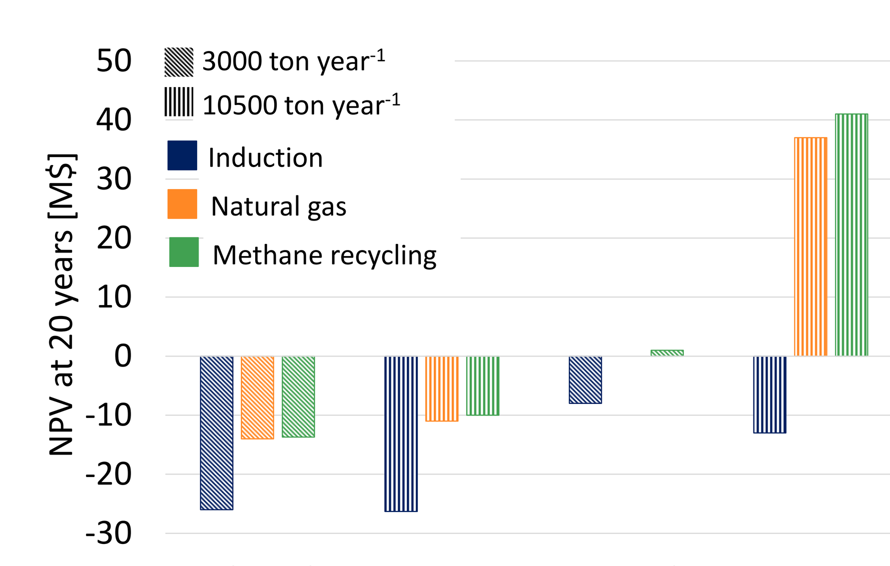
- Char Composition

	LAB plastic pyrolysis char	Whole battery pyrolysis char (Zhu & Chen, 2020)
Proximate analysis (%-wt)		
Moisture content	0.46	n.a.
Volatile matter content	5.71	n.a.
Ash content	72.95	n.a.
Fixed carbon	20.88	n.a.
Ultimate analysis (%-wt)		
C	20.51	85.28
H	1.16	11.48
N	1.12	0.56
S	0.05	n.a.
O	4.12	1.14

- Liquid Composition

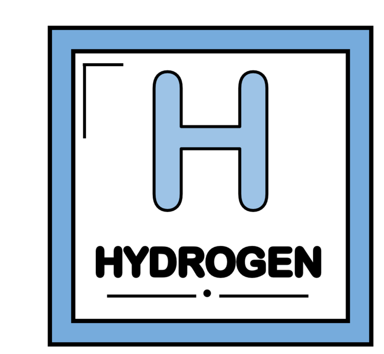
	C	H	N	S
OIL - Cond. 1	53.68 ± 3.11	5.88 ± 2.06	2.47 ± 1.30	0 ± 0
OIL - Cond. 2	69.40 ± 2.12	5.72 ± 0.25	2.39 ± 0.21	0 ± 0

- Techno-economic assessment



Conclusions

- At 550°C the liquid production is maximized
- At **650**°C the gas production is maximized and **39% of the feedstock is converted into hydrogen**
- A plant capacity of **3000 tons** per year is **not** economically **sustainable** in any case
- The **best scenario** is given by a plant size of **10500 tons** per year and **methane recycling**
- In this case a **payback period** of **4 years** and an **internal rate of return** of **30%** is achieved



Acknowledgements

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BAW REMEDIATION TECHNOLOGIES

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