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Life cycle analysis of pyrolysis of healthcare plastic waste

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Healthcare organisations generate large volumes of waste called as healthcare waste (or medical waste) which includes clinical waste, food, drugs, and medical devices, and disposed of in careful and often expensive ways. In 2016/17, over 590,000 tonnes of healthcare waste from the National Healthcare System (NHS) providers in England was generated[1]. The WHO estimated that 75-90% of waste from healthcare facilities is non-hazardous, similar to waste from other sites, for instance office or household waste[2].

With around 1500 hospitals in the UK[3], healthcare plastic waste presents a potential avenue for driving the circular economy in the NHS. Currently the majority of healthcare waste is managed according to HTM07-01[4] and is incinerated, hazard-waste-landfilled or sterilised before landfilling[1], although there are some recycling schemes in operation, such as RecoMed (by British Plastics Federation)[3]. Pyrolysis of healthcare plastic waste provides an opportunity to produce valuable products such as liquid fuel, gas and char[5], meaning that healthcare plastic can become a resource rather than being sent directly to landfill.

Pyrolysis has been studied extensively for various feedstocks[6]. However, to the best of our knowledge, the environmental impacts of using healthcare plastic waste as feedstock for pyrolysis have not been assessed. Consequently, this study focuses on: (1) pyrolysis process and characterisation of pyrolysis products and (2) environmental impact assessment using the life cycle analysis (LCA) methodology to analyse circularity of resources in healthcare organisations.

Currently, experiments are being conducted for pyrolysis process optimization. The pyrolysis is being conducted using fixed bed reactor, where the output is connected to mass spectrometry to quantify the emissions. The feedstock and the produced char, will be characterised for the elemental composition (C, H, N and O) to estimate lower heating value (LHV). To study the feasibility of the pyrolysis, the LCA is being undertaken using existing data from literature and experiments. The functional unit defined for the LCA in the present study is 1 kg of polystyrene that was chosen as one of the polymer from healthcare plastic waste, and the system boundary for the LCA includes the process inputs (like electricity use) and the co-products usage (**Fig.1**). The impacts evaluated are life-cycle greenhouse gas (GHG) emissions and fossil fuel use both during the pyrolysis process and in the treatment of products.

Sensitivity analyses in LCA was applied to investigate the influence of co-product handling methodology, product yield, and electricity grid composition. The present study will provide an understanding of using pyrolysis as a viable waste management alternative for healthcare plastic, that can reduce both GHG emissions by producing alternative fuels and the mass of waste sent to landfills.

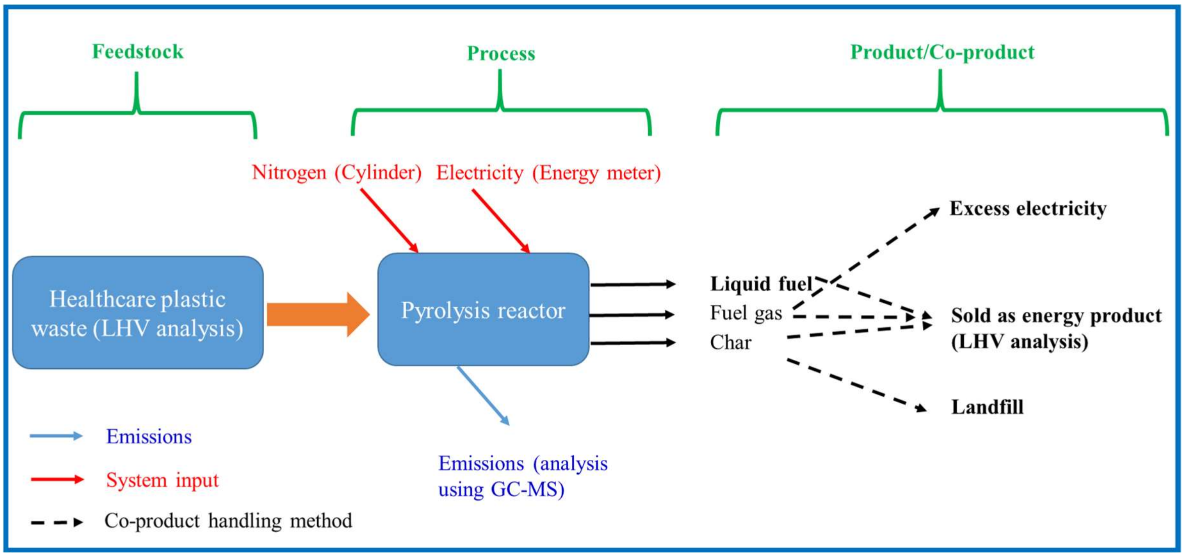

Fig.1. System boundary for life cycle analysis.

References

(1) Annual report of the Chief Medical Officer. 2017. Health impacts of all pollution-what do we know?

(2) WHO factsheet. https://www.who.int/news-room/fact-sheets/detail/health-care-waste

(3) British Plastics Federation. https://www.bpf.co.uk/recomed.aspx

(4) HTM07-01. 2013. Health technical memorandum: safe management of healthcare waste. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/167976/HTM_07-01_Final.pdf

(5) Iribarren, D.; Dufour, J.; Serrano, D. P. 2012. Preliminary assessment of plastic waste valorization via sequential pyrolysis and catalytic reforming. J. Mater. Cycles Waste Manag. 14 (4), 301–307.

(6) Jiang, T.; Zhao, X.; Gu, D.; Yan, C.; Jiang, H.; Wu, H.; Wang, B.; Wang, X. 2020. STEP polymer degradation: Solar thermo-coupled electrochemical depolymerization of plastics to generate useful fuel plus abundant hydrogen. Sol. Energy Mater. Sol. Cells, 204, 110208.