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# Thermogravimetric catalytic pyrolysis of high-density polyethylene over iron modified chicken eggshell wastes

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A B S T R A C T

Among the major concerns of our current world include the accumulation of plastic wastes and the exhaustion of petroleum resources. Efforts to resolve these issues have contributed to multiple research and alternatives to be explored. One of the attractive alternatives that have been approached is the pyrolysis of plastic wastes. The use of catalysts offers multiple advantages in pyrolysis and different types of catalysts have been investigated in recent years. The potential of discarded natural wastes is acknowledged and studies to use food waste as a catalyst are to be developed in this research. The main objective of this project is to investigate the pyrolysis of high-density polyethylene (HDPE) over iron (Fe) modified waste chicken eggshell (WCE) as the catalyst. The pyrolysis was conducted at a temperature of 30 – 700℃ via a Thermogravimetric analyzer (TGA). WCE was washed, dried, and calcined in the furnace at 900℃ for 4 h. Fe was loaded (5 wt%) on the calcined WCE via the incipient wetness impregnation (IWI) method. The catalyst to HDPE mass ratio was fixed at 1:1. For comparison purposes, the commercial calcium oxide (CaO), calcined WCE, and Hydrogen exchanged Zeolite Socony Mobil – 5 (HZSM-5) were utilised in the pyrolysis of HDPE. Catalytic pyrolysis of HDPE over WCE and CaO had almost completely degraded with mass loss of 99.50% and 99.83% respectively at Phase II followed by pyrolysis of HDPE (94.05%), HZSM-5 (77.50%) and Fe/WCE (31.40%) samples. Among tested catalytic samples, the WCE catalyst works best to degrade HDPE into the highest volatile matter which attributes to higher pyrolysis oil yield.

## 1. Introduction

Energy has become an inevitable part of our life. As our life progresses, the dependency on energy is expected to increase along with the creation of new technologies and devices. This requires a continuous supply of energy that meets the demand while ensuring minimized effects on the environment. Fossil fuels that have been long in use do not meet both these requirements [1]. Renewable energy ticks off the criteria but it is still in development, making it not possible to fully depend on it, and therefore another alternative energy source is needed [2]. Waste-to-energy generation can be one of the potential sources of energy that can be developed as an alternative energy source [3]. Waste generation has been growing continuously worldwide and is expected to reach up to 2.2 billion tons per year by 2025 [2]. Most of the plastics are used for packaging purposes, about 40% of the total packaging waste is dumped in landfills and 32% of the waste is disposed of into the environment [4]. High-density polyethylene (HDPE) is a common plastic due to its desirable properties such as being durable, light, cheap, and versatile. This accounts for the increased usage and waste generation of HDPE. The proper management of plastic waste can be a good initiative to minimize the exhaustion of natural resources. Among available recycling methods for plastic waste, thermochemical recycling is highly preferable due to the potential recovery of petrochemical products from plastic waste. In addition, this technique enables the production of fuel or chemicals that can be utilised for the production of new plastics [5]. Pyrolysis as one of the highly preferable thermochemical methods is

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