Environmental Impact Assessment on Plastic Waste Pyrolysis: Case Study in Banjarnegara District, Indonesia

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ABSTRACT

This research take a case study in Banjarnegara that produce liquid fuels from plastic waste.

- The goal of the study was to assess the environmental impacts of pyrolyzing many different plastic residual streams and producing fuel.
- The environmental impact categories analyzed include Human toxicity, Terrestrial ecotoxicity, Freshwater ecotoxicity, Water consumption, Global warming potential, and Fine particulate matter formation.

The type of plastic used:

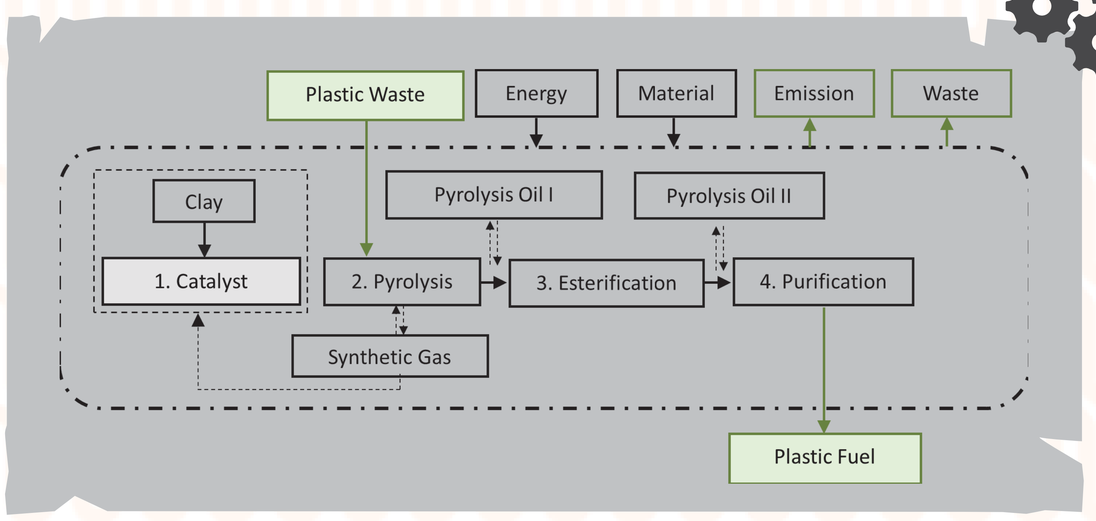
- 70% HDPE (High Density Polyethylene) and LDPE (Low Density Polyethylene)
- 30% Polypropylene (PP) and Polystyrene (PS).

Using bentonite as catalyst

Pyrolysis machine:

- 100 - 400 kg capacity, using firewood as fuel
- works at an optimal temperature of 250 - 325 °C during 8 hour production process
- produces 90-95 liters of fuel (95% diesel-equivalent and 5% gasoline-equivalent)

SYSTEM BOUNDARY



RESULT

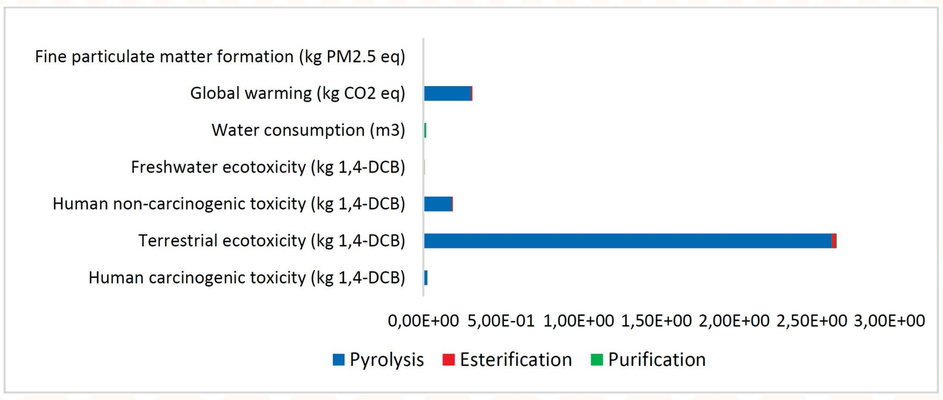
This analysis aims to quantitatively assess the environmental impact of fuel production process from plastic waste. The scope of this research is “gate-to-gate“, where the life cycle analysis is limited to the production process only. The functional unit in this analysis is 1 (one) liter of fuel (diesel-equivalent).

Impact Category	Impact Assessment Result	Normalization
Human carcinogenic toxicity	2.50E-02 kg 1,4-DB	9.03E-03
Freshwater ecotoxicity	5.90E-04 kg 1,4-DB	5.69E-03
Terrestrial ecotoxicity	2.57E+00 kg 1,4-DB	2.56E-03
Human non-carcinogenic toxicity	1.90E-01 kg 1,4-DB	1.27E-03
Water consumption	1.78E-02 m^3	6.66E-05
Global warming	3.15E-01 kg CO2 eq	3.95E-05
Fine particulate matter formation	5.90E-04 kg PM2.5 eq	2.32E-05

Table 1. Impact Assessment Result and Normalization (Source: Own Calculation, OpenLCA Output)

Data were analyzed using OpenLCA with the LCIA method namely ReCiPe Midpoint 2016 and World 2010 normalization factors.

The normalization process is carried out to determine the influence of various impacts with different units in the form of person equivalent units.



Graph 1. Environmental Impact Contribution (Source: Own Calculation, OpenLCA Output)

LARGEST IMPACT CATEGORIES

Three largest impact categories on the environment were human carcinogenic toxicity, freshwater ecotoxicity, and terrestrial ecotoxicity, respectively.

IMPACT ON HUMAN HEALTH

Recycling plastic waste using the pyrolysis method had a better environmental impact in the category of global warming potential, freshwater ecotoxicity, and terrestrial ecotoxicity, but its worse in human carcinogenic toxicity (compared to incineration).

CONCLUSION

ACTIVITY/PROCESS HOTSPOT

The activity/process unit that produce the greatest impact (hotspot) was the pyrolysis stage. Meanwhile, the purification stage had the least impact.

POSSIBILITY FACTORS

The environmental impact resulting from the pyrolysis process was influenced by the use of fuel for the pyrolysis machine, the use of water, electricity and other chemicals such as NaOH and methanol.

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