Ending Plastic Waste Symposium 2024

CHARACTERIZATION OF PYROLYSIS OIL FROM MIXED PLASTIC WASTE (PE, PP) AND POLYSTYRENE (PS) BY BANJARNEGARA WASTE BANK AS ALTERNATIVE ENERGY SOURCE

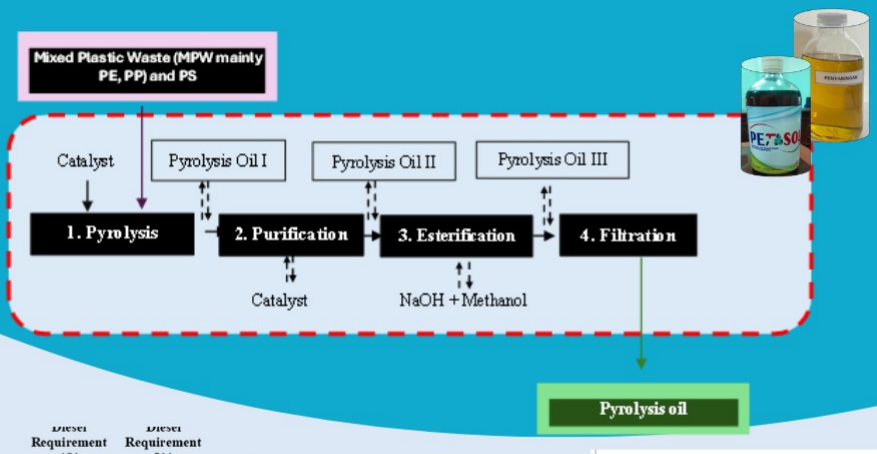
Nugroho Adi Sasongko1, Heru Susanto1*, Budi Trisno Aji2, Rahadian Mawardi1, Tri Cahyono1, Elly Kristiani Purwendah3, Helena Lina Susilawati1, Maharani Dewi Solikhah4, Tri Martini 1

1 Research Center for Sustainable Production and LCA, National Research and Innovation Agency (BRIN), Technology Innovation and Business Center Building Number 720 KST B.J. Habibie Serpong Tangerang Selatan 15314
2 Banjarnegara Waste BAnk (BSB), Kasilib Village RT 004 RW 002, Wanadadi District, Banjarnegara Regency, Central Java Province
3 Faculty of Law, Wijayakusuma University Purwokerto, Purwokerto, Central Java, Indonesia
4 Research Center for Energy Conversion and Conservation, National Research and Innovation Agency (BRIN), Technology Innovation and Business Center Building Number 720 KST B.J. Habibie Serpong Tangerang Selatan 15314
* heru031@brin.go.id

Abstract

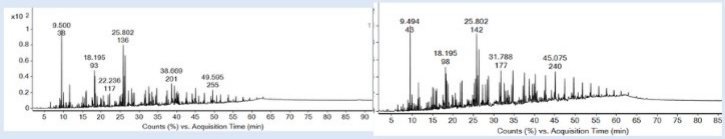
Oil from pyrolysis of plastic waste can manage waste and serve as a renewable energy source. Bank Sampah Banjarnegara (BSB) in Indonesia converts plastic waste into fuel, which has not been characterized until this study. The study aims to characterize pyrolysis oil from BSB's plastic waste as a fuel substitute. The plastic waste tested includes mixed plastic waste (MPW, mostly polyethylene/PE and polypropylene/PP) and Polystyrene (PS) types.. Pyrolysis used a multi-condenser machine at 250-325°C, followed by purification, esterification, and filtration. The resulting MPW and PS pyrolysis oil are similar to standard diesel oil (diesel 48) following Decree No. 146/2020. Cetane numbers were 48.6 for MPW and 53.4 for PS, with densities slightly below the standard (814.6 and 809.8 kg/m³). PS had better sulfur content (73.56% m/m) than MPW (890% m/m), both within the 2000% m/m limit. The types of compounds contained in MPW are mostly aliphatic compounds while PS is dominated by oxygenate compounds. The study indicates that waste plastic is a promising alternative fuel source, with PS being highly effective in reducing sulphur content, which has a positive impact on diesel engine emissions..

Methods



Results

No	Test Parameter	Method	Unit	MPW	PS	Diesel Requirement 48*	Diesel Requirement 51*
1	Cetane Number	ASTM D613	-	48.6	53.4	min. 48	min. 51
2	Cetane Index	ASTM D4737	-	60.45	70.97	min. 45	min. 48
3	Density at 15 °C	ASTM D4052	kg/m³	814.6	809.8	815-870	810-850
4	Viscosity at 40 °C	ASTM D445	mm²/s	2.792	3.332	2.0 – 4.5	2.0 – 4.5
5	Moisture content	ASTM D6304	% m/m	108.46	86.43	max. 400	max. 280
6	Acid Number	ASTM D664	mg KOH/g	0.02	0.03	max. 0.6	max. 0.3
7	Sulphur content	ASTM D4294	% m/m	890	73.56	max. 2000	max. 500
8	Flash Point	ASTM D93	°C	52	73	min. 52	min. 55
9	Cloud Point	ASTM D2500	°C	n.d	11.5	max. 18	max. 18
10	Pour Point	ASTM D97	°C	1.5	6	max. 18	max. 18
11	Carbon Residue	ASTM D189	% m/m	0.03	0.01	max. 0.1	max. 0.1
13	Copper Strip Corrosion	ASTM D130	class	1a	1a	max. class 1	max. class 1
14	Ash Content	ASTM D482	% m/m	<0.005	<0.005	max. 0.01	max. 0.01
15	Sediment Content	ASTM D473	% m/m	0	0	max. 0.01	max. 0.01
16	Particulate Contamination	ASTM D6217	mg/l	4.1	7.2		max. 10
17	Colour	ASTM D1500	No. ASTM	3.2	3.0	max. 3	max. 1
18	Lubricity	ASTM D6079	micron	353.5	450	max. 460	max. 460



No	Compound Type	% Area MPW*	% Area PS*
1	Aliphatic	54.46	34.14
2	Aromatic	22.85	26.57
3	Oxygenates	22.69	39.29

MPW : *Mixed Plastic Waste (mainly PE and PP)*, PS : *Polystyrene*

- The pyrolysis machine has been registered for intellectual property rights under patent number P00202314623.
- The salt-activated bentonite catalyst has been registered for intellectual property rights as a registered patent (P00202405655).

Recommendation

- Pyrolysis oil from MPW and PVC show similar characteristics to diesel oil (diesel 48) standards per Decree No. 146/2020. Cetane numbers were 48.6 for MPW and 53.4 for PVC, with densities slightly below the standard (814.6 and 809.8 kg/m³). PVC had better sulfur content (73.56% m/m) than MPW (890% m/m), both within the 2000% m/m limit.
- The types of compounds contained in MPW are generally aliphatic compounds, while PS is dominated by oxygenate compounds.
- Plastic waste is a promising alternative fuel source, with PS particularly effective in reducing sulfur content, impacting diesel engine emissions positively.

SCAN ME