Pyrolysis of polyolefin-based plastic wastes for liquid fuel production: A pilot-scale study.

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Chemical recycling, such as pyrolysis, has the potential to raise recycling rates since it can use more waste plastics than standard mechanical recycling. Four types of plastic, polyethylene (PE), polypropylene (PP), polystyrene (PS), and biaxial-oriented polypropylene (BOPP) fractions from the printing plant were collected and investigated for the possibility of recycling them by batch pyrolysis. Characterization of the pyrolysis oils was carried out by gas chromatography-mass spectrometry (GC-MS) and FT-IR method, the analysis showed a mixture of aliphatic (saturated and unsaturated) compounds, in the case of PE and PP, while in the case of PS aromatics and low quantities other hydrocarbons were detectable.

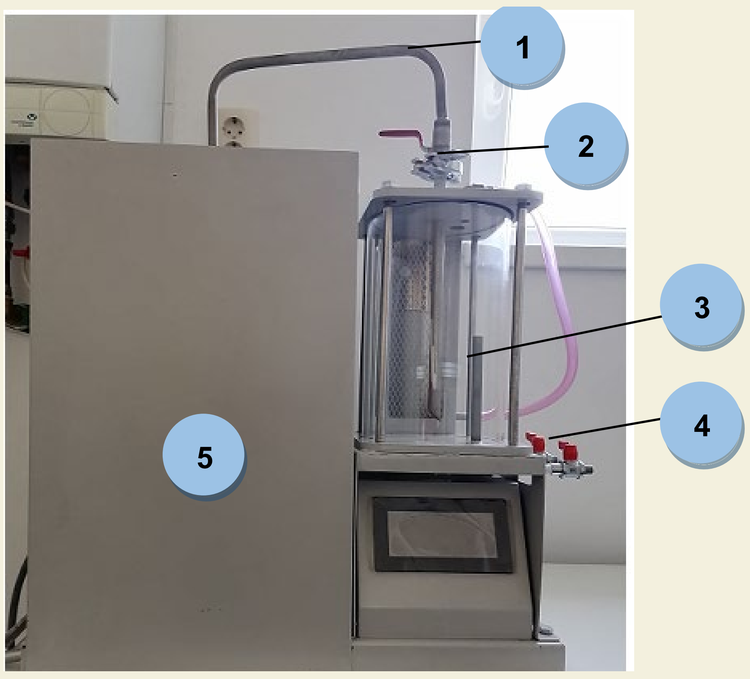

Figure 1. The used plastic oil maker, Be-j, equipment Components: 1. Gas tube; 2. Anti-counter current valve; 3. Water tank; 4. Oil taking valve; 5. Pyrolysis chamber, with stainless steel outer chamber.

Table 1. Physicochemical and thermal properties of the obtained pyrolysis oil.

S. No	Parameter	Unit	PE white	PE with ink	PS	PP transparent	BOPP with ink
1	Density (at 20°C)	g/cm^3	0.7596	0.7648	0.9252	0.7631	0.7251
2	Flash point	°C	22	21	30	22	37
3	Gross Caloric Value	KJ/g	44.78	42.48	41.81	45.10	36.67
4	Aniline point	°C	72.2	67.8	21.7	67.6	57.7
5	I.D. (diesel index)		86.83	80.65	47.57	81.09	84.65

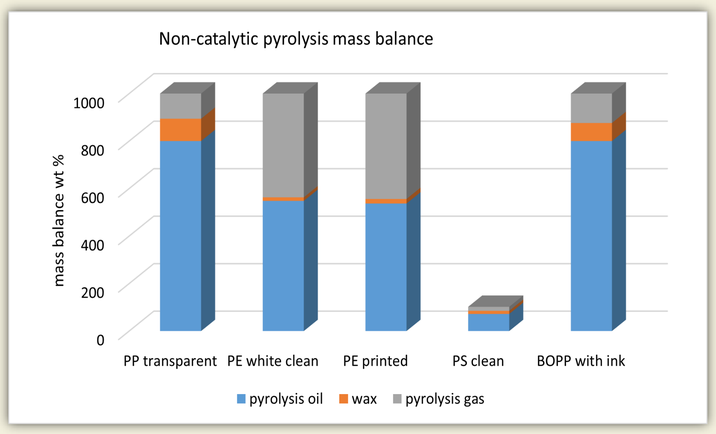

Figure 2. Pyrolysis product yield, using plastic waste in non-catalytic experiments.

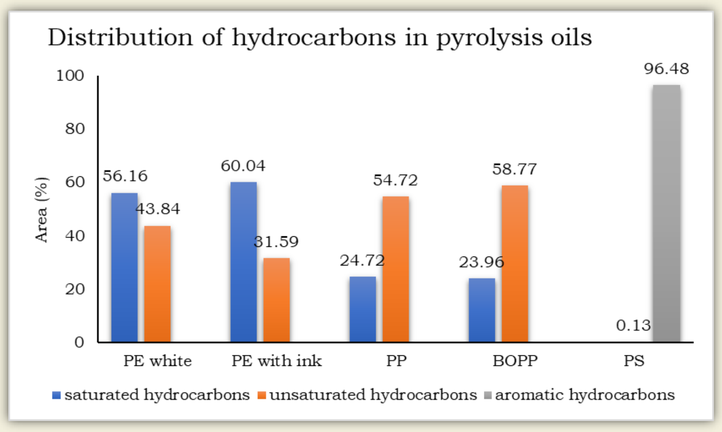

Figure 3. Distribution of hydrocarbon types in pyrolysis oil based on GC/MS analysis

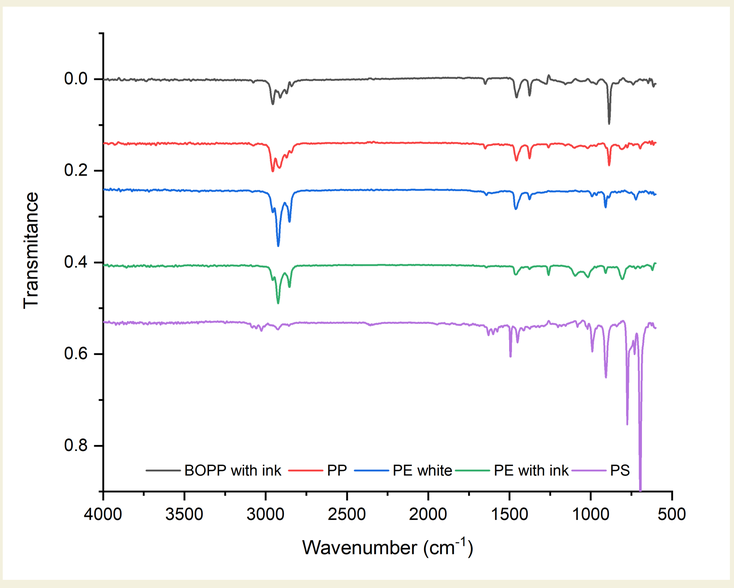

Figure 4. Comparison of FT-IR spectra of pyrolysis oil obtained from different raw materials

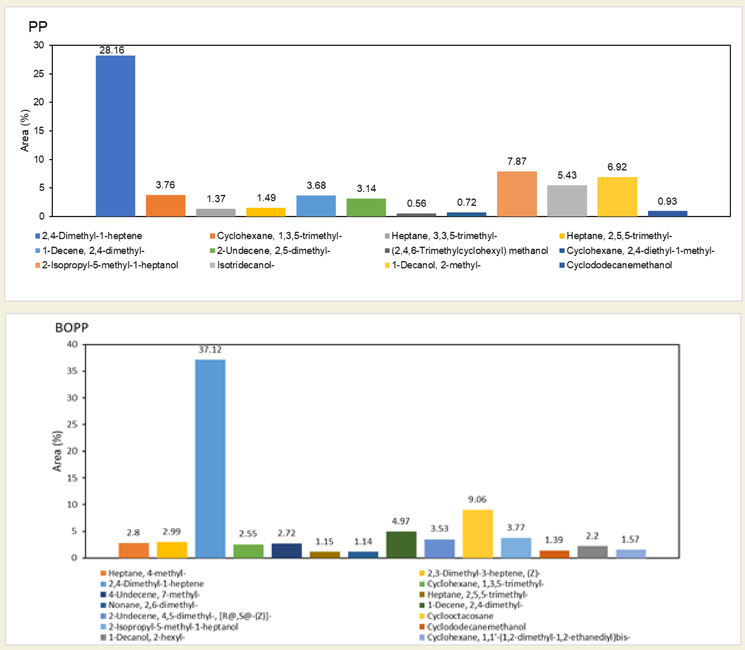

Figure 5. Distribution of compounds in pyrolysis oil (PP and BOPP) based on GC/MS analysis

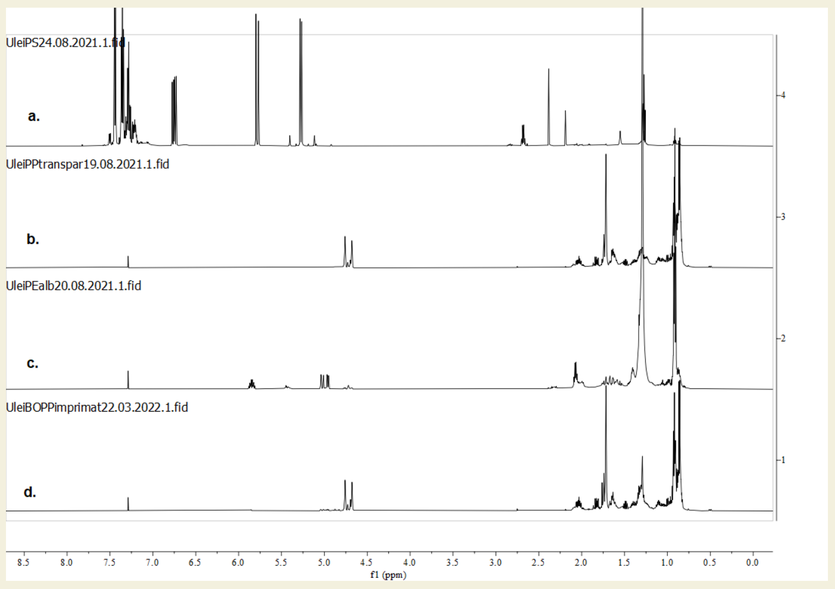

Figure 6. Comparison of ^{1}H NMR ($CDCl_3$, 600MHz) spectra of pyrolysis oil obtained from different raw materials

Conclusions

- ✓ The calorific value of oil varies between 36- 45 KJ/g depending on the plastic quality, similar to that of conventional diesel.
- ✓ The flash point values of the pyrolysis oil can be improved by removing lighter components from the oils.
- ✓ Hydrocarbon fingerprinting of pyrolysis oil has been matched using GC–MS, FT-IR, and ^{1}H, ^{13}C NMR respectively, to understand the feasibility of using it. The analysis of the composition of the oil fraction originating from PE and PP using GC-MS confirmed the formation of both linear alkanes and alkenes ranging from C_8 to C_{24}.
- ✓ Styrene can be obtained in a high yield (68%) from the PS pyrolysis without catalyts, and the obtained monomer after treatment can be reused for further polymerization or other valuable chemicals.

References
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Equipments

- ❖ Bruker Avance 600 MHz NMR,
- ❖ Shimadzu GC-MS QP-2010 PLUS
- ❖ Bruker Vector 22 FT-IR