Batch pyrolyzed biooil assessment as an alternative fuel from plastic resins and waste rubber tires at different temperatures

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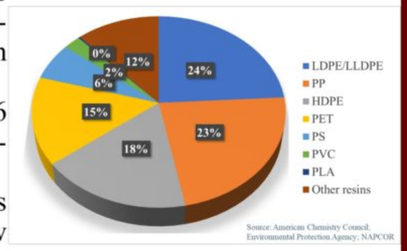
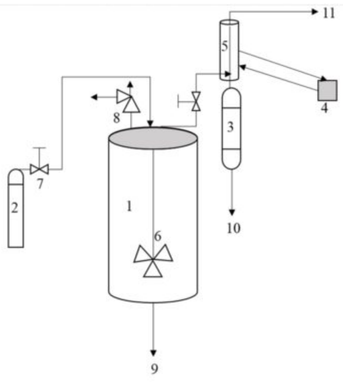
INTRODUCTION

- In 2018, plastics generation was 35.7 million tons in the United States, which was 12.2 percent of MSW generation: 75% landfilled, 15.8% incinerated, and only 8.7% recycled.
- Also, 18.2 % of MSW was from rubber and Leather products in 2018 while 5 million landfilled resulting pollution.
- US alone sends between 246 million and 300 million end-of-life tires to waste annually.
- Globally, rubber and plastics products are expected to grow about 10.4% annually.
- Current U.S. actions to control plastic pollution are yet to include the plastic conversion into fuel.
- Pyrolysis is a promising step for thermal conversion of waste burden to energy.



Objective: Pyrolyze plastic resin and rubber tire waste at different temperature and catalysts to minimize waste, pollution, and gain alternate energy.

METHODOLOGY

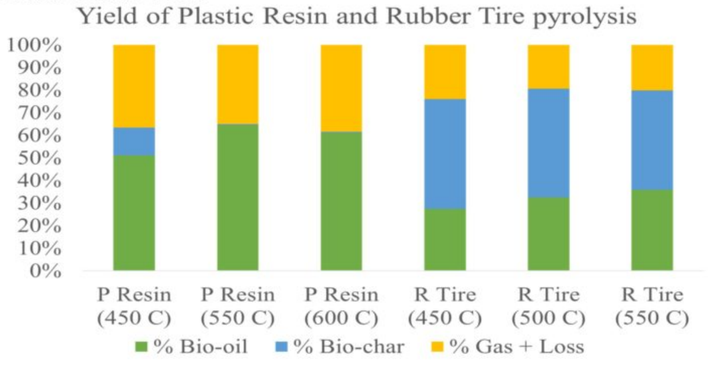


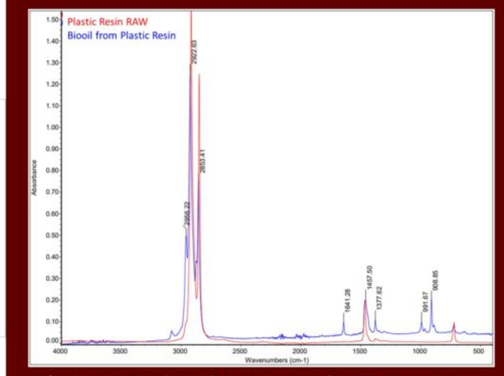
1. Reactor
2. N2 Cylinder
3. Biooil storage
4. Chiller at 32 F
5. Condensation unit
6. Stirrer
7. Gas valve
8. Pressure Gauge
9. Biochar collection
10. Biooil Collection
11. Biogas collection

Figure: Schematic design of the pyrolysis system.

RESULTS

Table: Biooil Yield





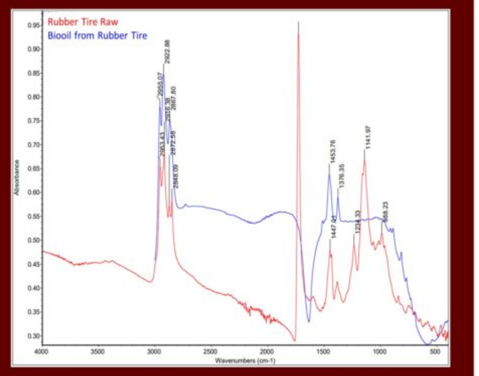
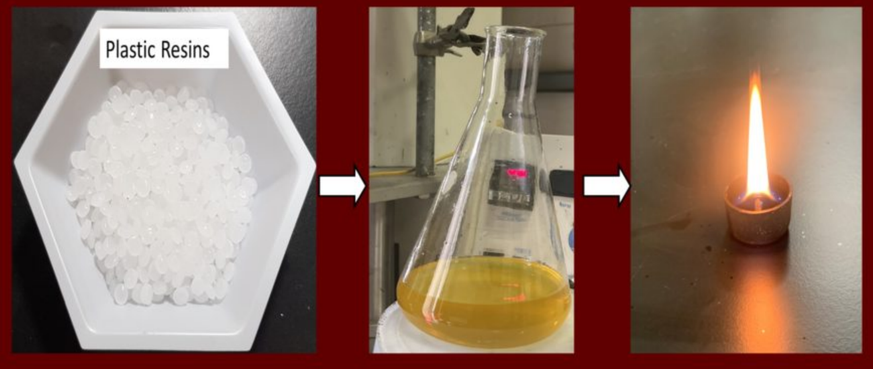


Figure: Biooil and Raw sample FTIR spectra

Highlights

- At 550 C, optimum biooil yield was achieved (60-65% for plastics; while 35% for rubber tire).
- Less than 1% residual solid was recovered from plastic pyrolysis, while up to 44% of solid residue (char) was obtained from rubber pyrolysis.
- Heating value of biooils from rubber tire and plastic resins were 38.73 MJ/kg and 45.36 MJ/kg, consecutively.



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MORE RESULTS

Table: Achieved Biooil physicochemical properties

Parameter	Plastic Resin Biooils				Rubber Tire Biooils			
	@ 450 °C	@ 550 °C	@ 600 °C	Avg.	@ 450 °C	@ 500 °C	@ 550 °C	Avg.
pH	5.26	5.3	5.27	5.28	9.12	8.96	9.12	9.07
DO (mg/l)	14.98	14.22	14.98	14.73	15.19	14.84	15.19	15.07
Density (g/ml)		0.748[c]		0.748	0.756	0.777	0.776	0.77
K. Viscosity[a] (cSt)	1.22	1.08	1.06	1.12		1.11[c]		1.11
D. Viscosityb (cP)	0.91	0.81	0.80	0.84	0.84	0.86	0.86	0.85
HV (MJ/Kg)		45.57[c]		45.57[c]		38.73[c]		
Acid Value	0.2	-	-	0.2[d]	1.3	2.5	3.6	2.5[d]
Visual Color	Yellow to Orange				Initially olive green to blackish			
Flash Point	<30 °C							

[a] measured at 40 °C
[b] measured using density and Kinematic viscosity relationship
[c] Average values
[d] Preliminary assessment, need verification

Table: Compounds matched from biooil FTIR spectra

SI	Biooil from Plastic Resins		SI	Biooil from Rubber Tire	
	Match (%)	Compound name		Match (%)	Compound name
1	93.10	Sorbitan monostearate; Span 60	1	80.15	Octane
2	93.02	Poly(ethylene:propylene:diene)	2	79.36	Thermoplastic elastomer
3	92.90	Poly(ethylene:propylene: ethylidenenorbornene)	3	78.88	Poly(acrylic acid, ammonium salt)
4	92.83	Poly(ethylene:propylene:diene)	4	77.21	Mineral oil
5	91.83	Poly(ethylene:propylene:diene)	5	76.52	Chromium(III) chloride .6H2O
6	89.57	Thermoplastic elastomer	6	76.48	Poly(acrylic acid, ammonium salt)
7	88.54	Lithium nitrate	7	75.60	Synthetic polyterpene
8	87.75	Poly(ethylene:propylene: ethylidenenorbornene)	8	74.95	Sodium orthovanadate
9	87.58	Sodium orthovanadate	9	74.28	Sodium orthovanadate
10	87.53	Pyrophosphate disodium	10	74.23	Lithium Nitrate

Future Work

1. Utilize different Catalysts to improve the biooil yield and quality
2. Purify the biooil to fuel grade using distillation, fractionation, solvent attraction, catalysts bed filtration, Plasma treatment.

Acknowledgement

1. All Data are proprietary property of eAI Institute
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