Thermal Treatment of the High ash Coal with Electronic Waste plastics and Characterization of the Co-liquefied oil

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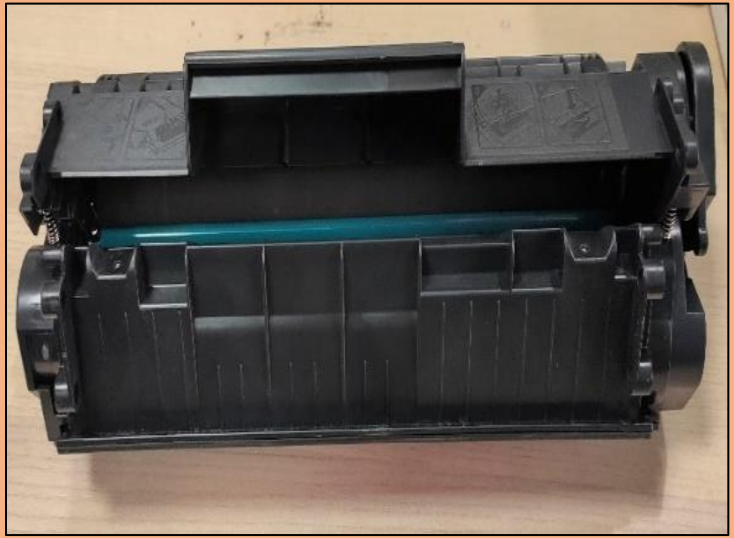
Alternate energy source

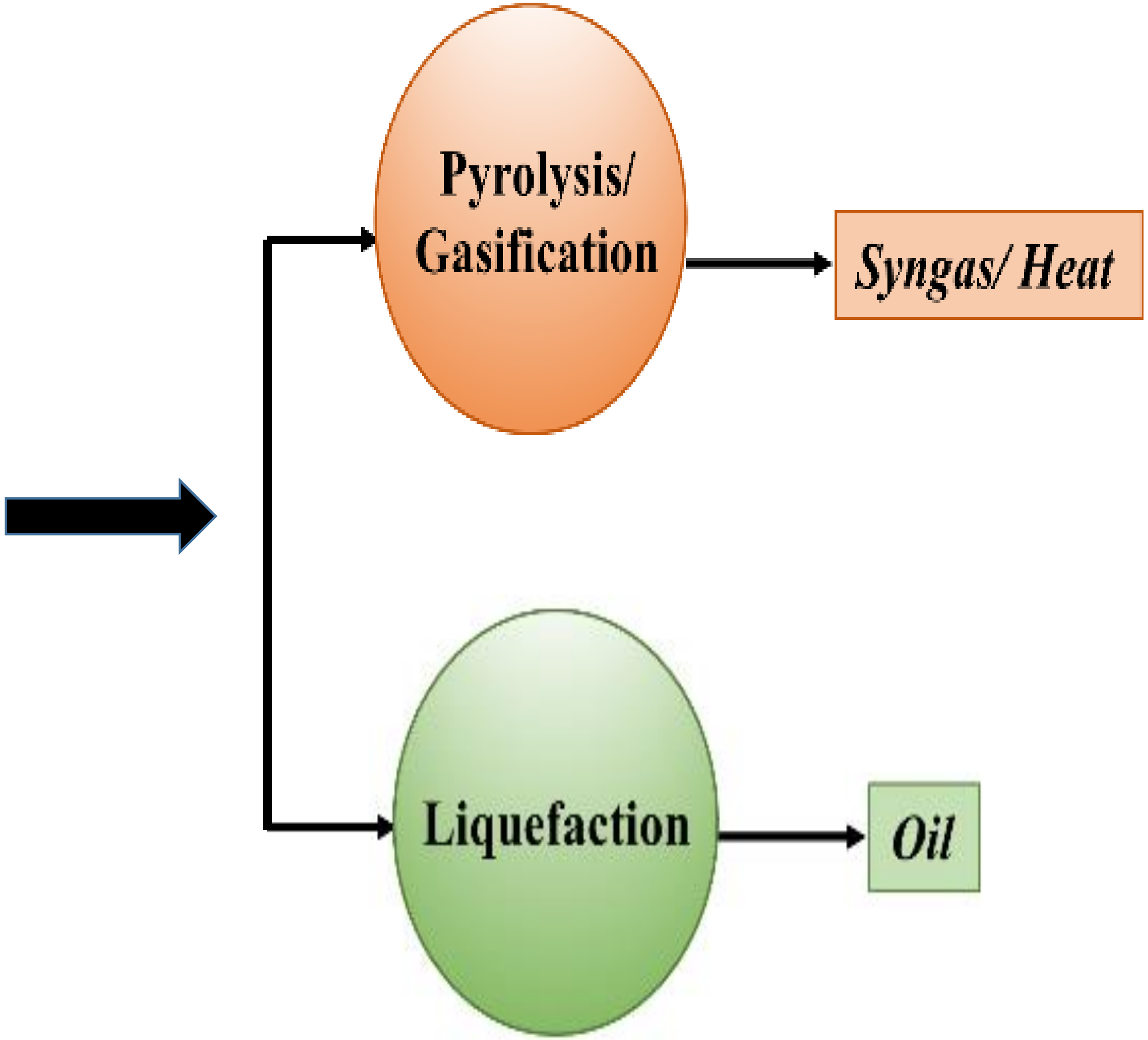
- Energy demand is increasing highly with the rapid economic growth all over the world

- High crude oil price and decreasing resources have enhanced the value of alternative liquid hydrocarbon fuels

- **Coal** and **electronic waste (E-waste)** materials are potential sources for the production of transportable oil

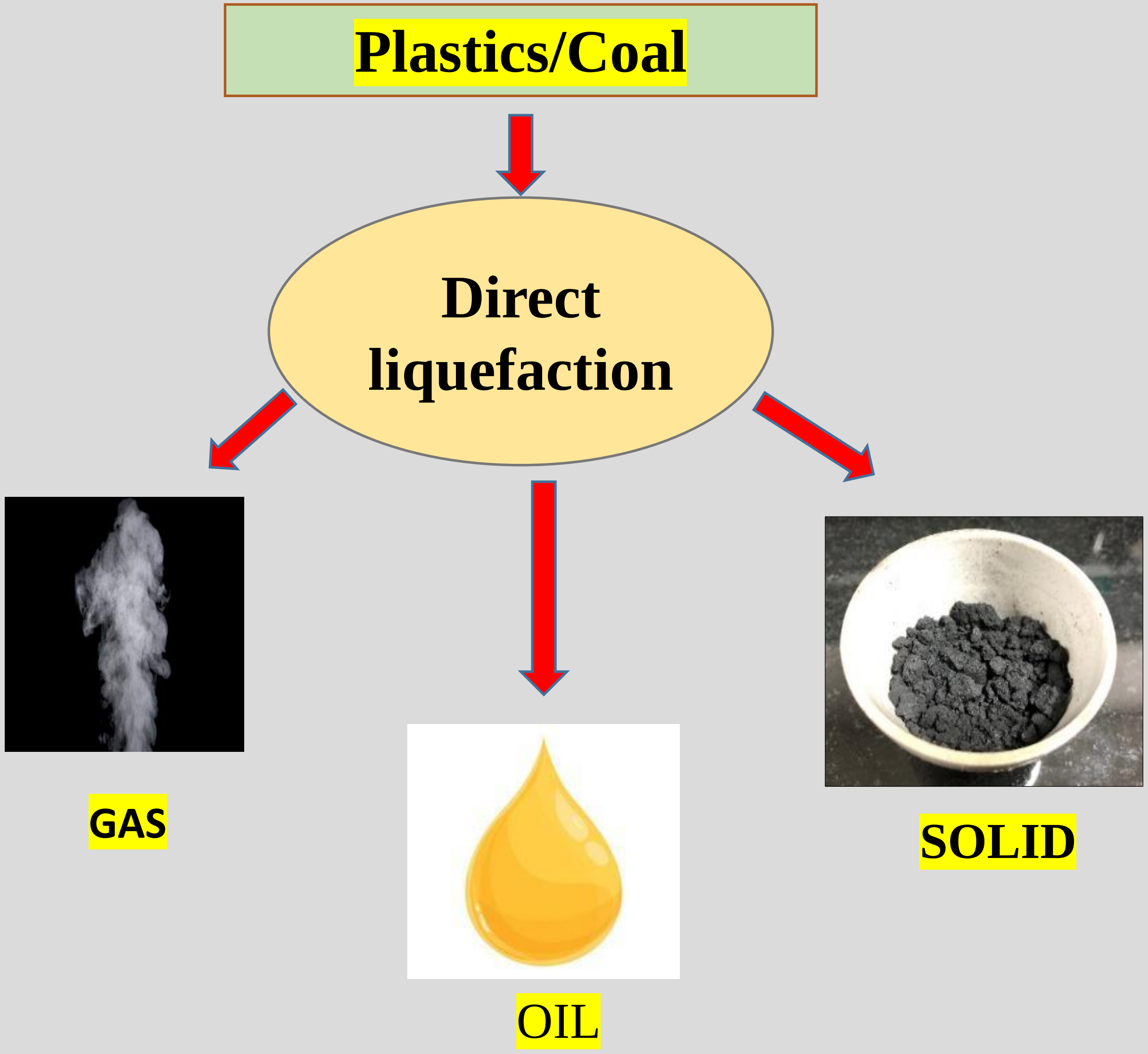


Thermochemical treatment

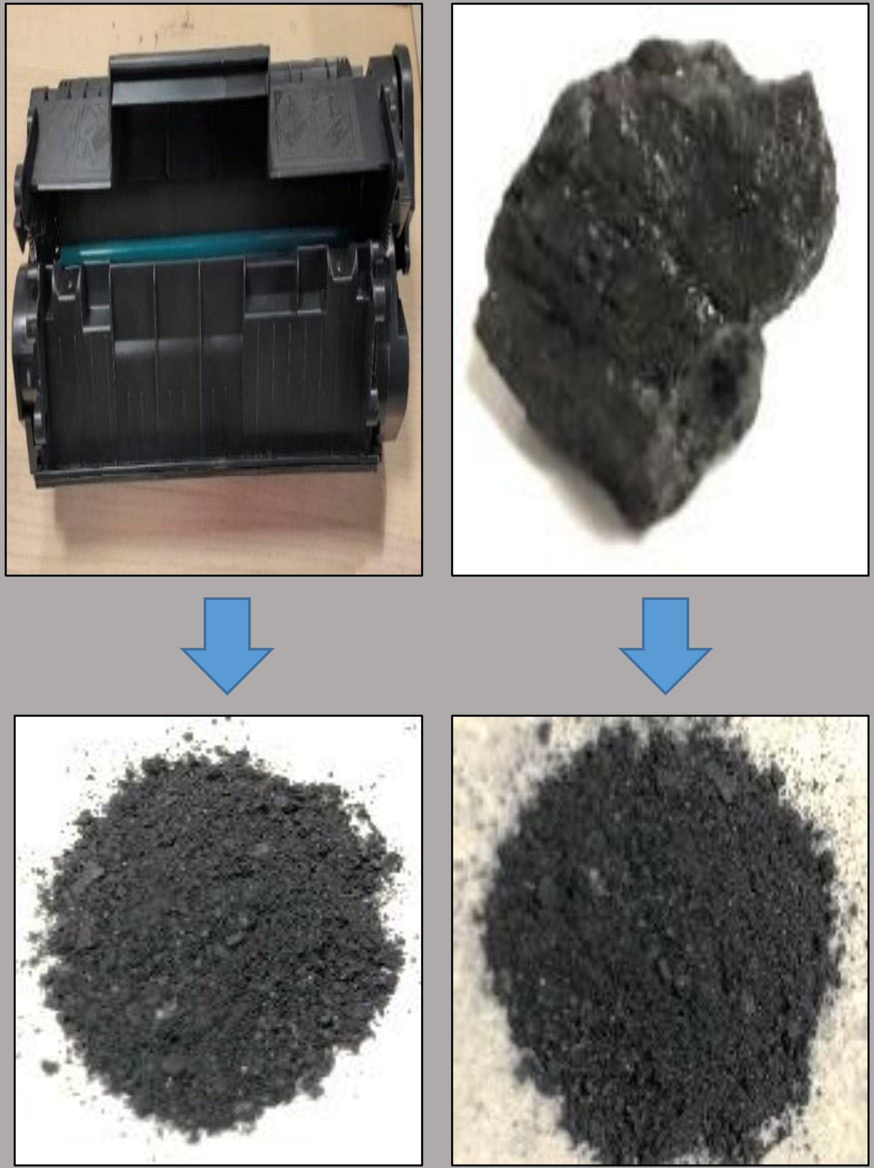


Direct Liquefaction (DL)process

- DL is an attractive process to convert waste plastics and coal into transportable liquids
- Co-liquefaction of coal and plastic enhances product yields and their quality (Heating value, H/C ratio etc.)
- Co-liquefaction becomes energy efficient and economically viable approach altering the need for costly hydrogen

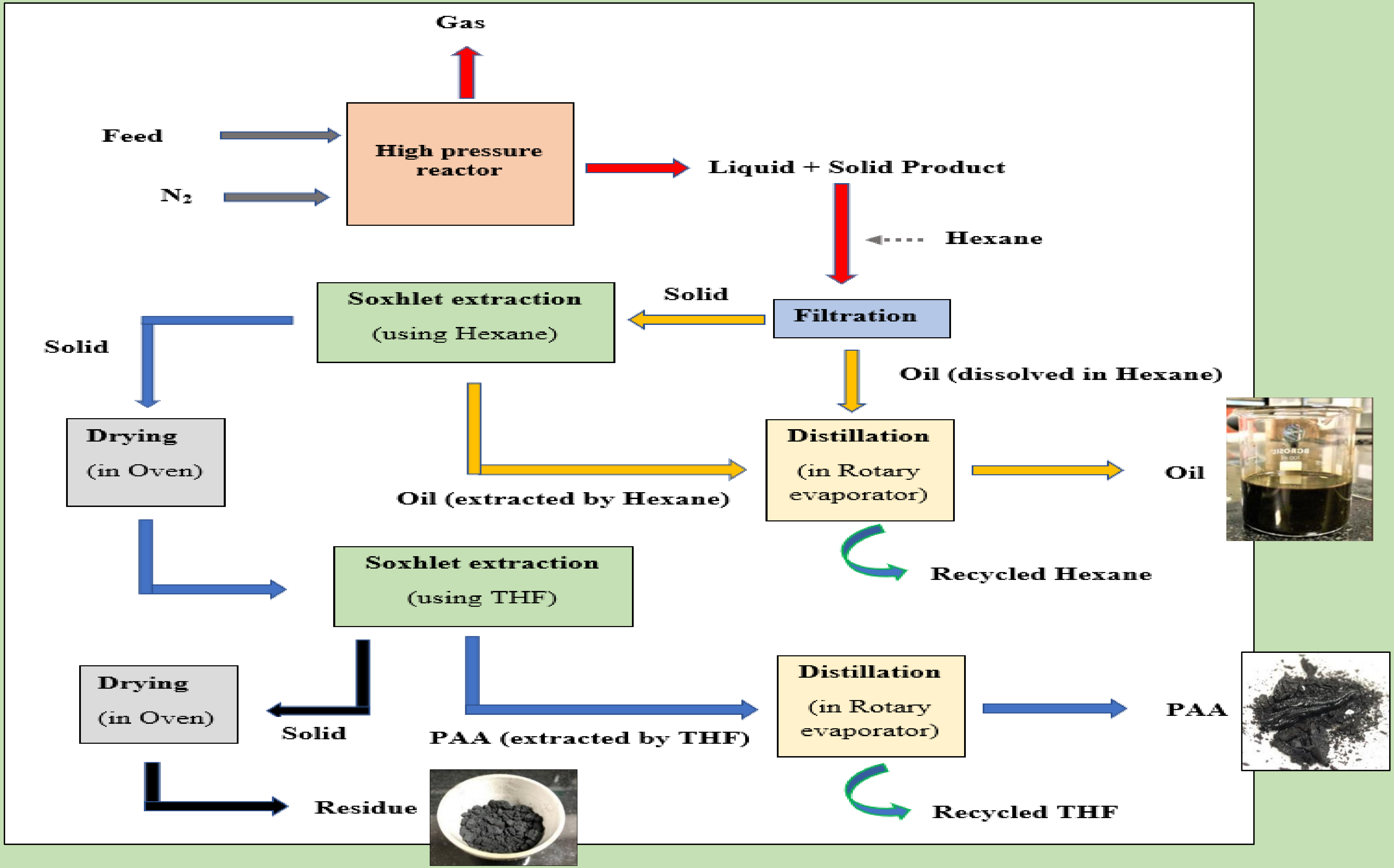


Materials

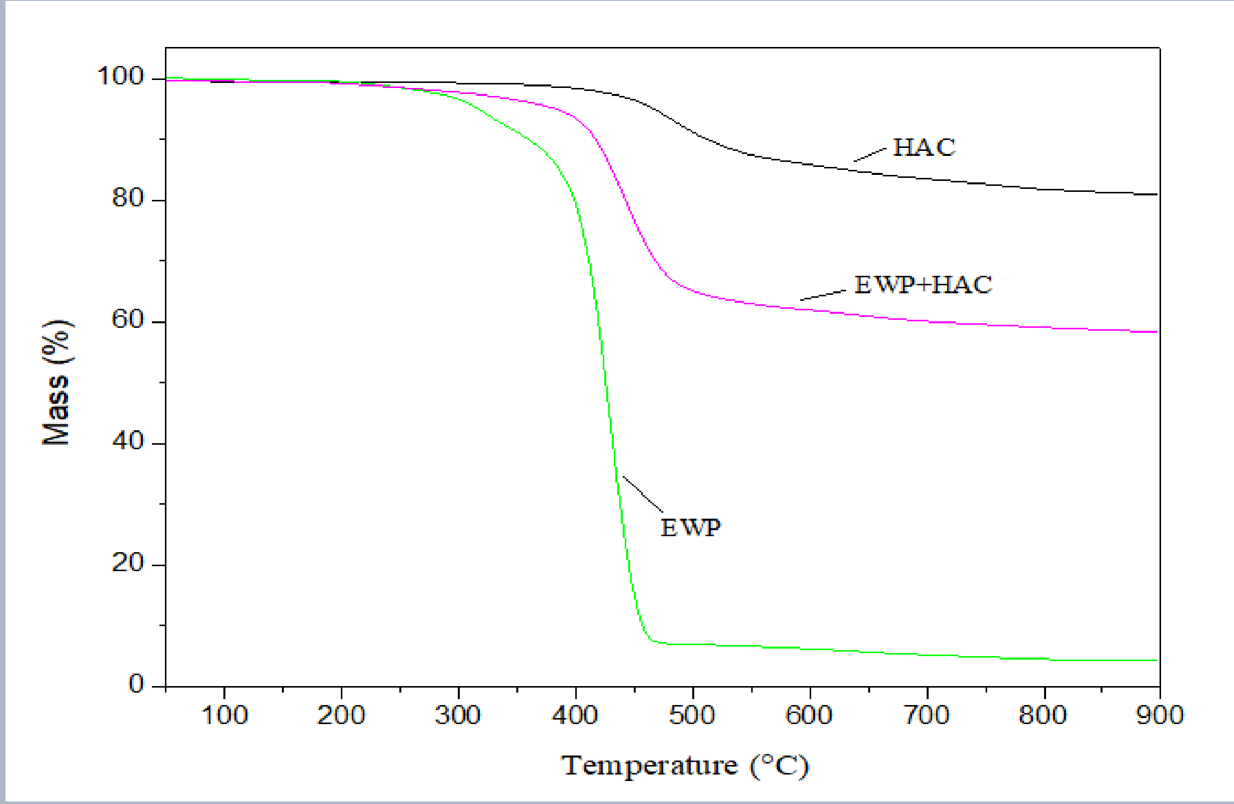


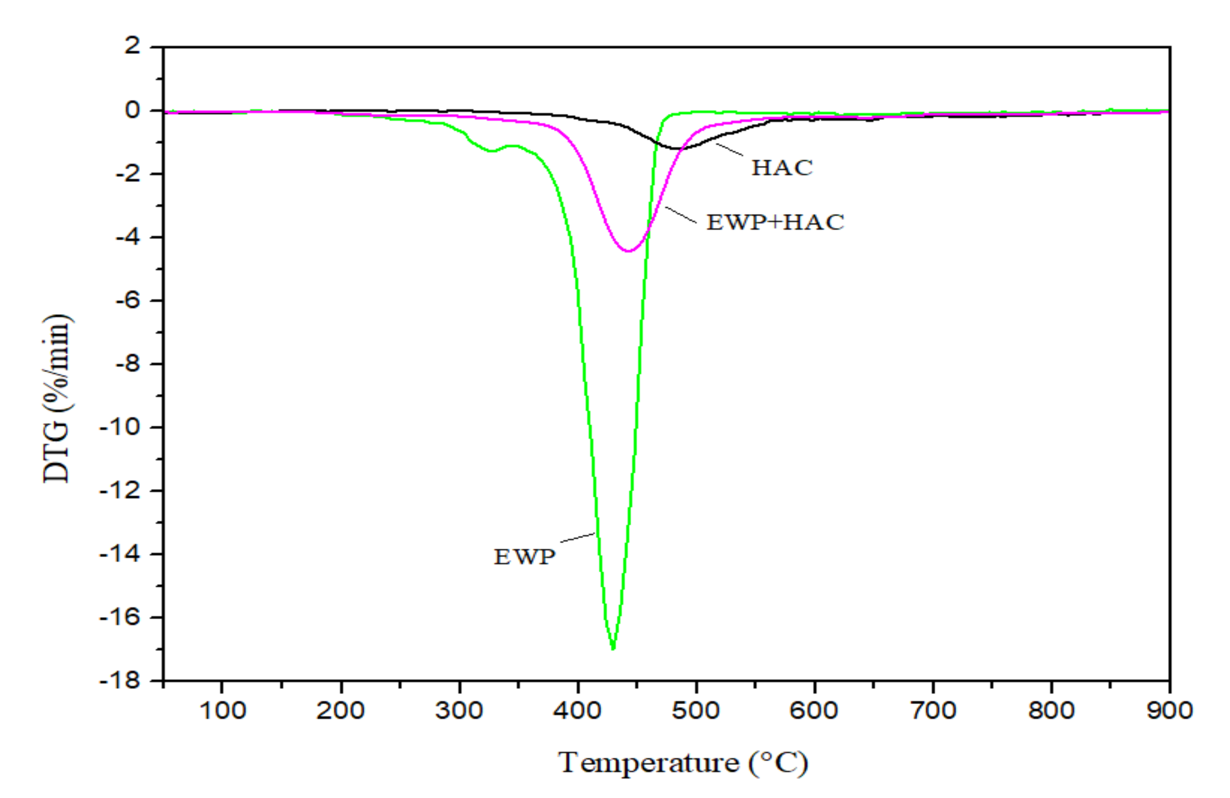
Analysis	HAC	EWP
Proximate analysis		
Moisture (wt. %)	2.1	0.83
Volatile matter (wt. %)	20.8	94.32
Ash (wt. %)	30.4	1.13
Fixed carbon (wt. %)	46.4	3.72
Ultimate analysis		
Carbon (wt. %)	58.75	83.34
Hydrogen (wt. %)	3.06	8.40
Oxygen (wt. %)	36.32	7.01
Nitrogen (wt. %)	1.77	1.25
Sulfur (wt. %)	0.10	-
Calorific value (MJ/kg)	22.30	37.86

Experimental procedure



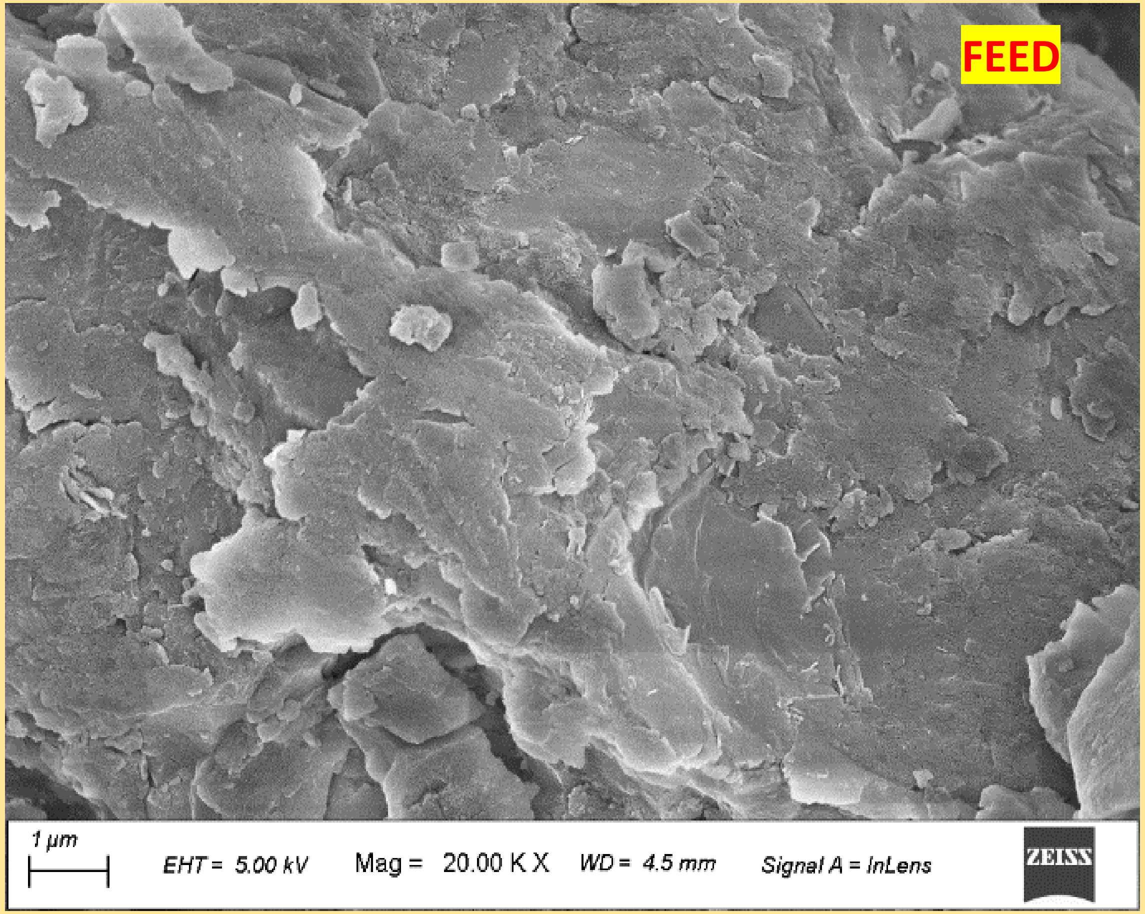
Thermogravimetric analysis of Feed samples

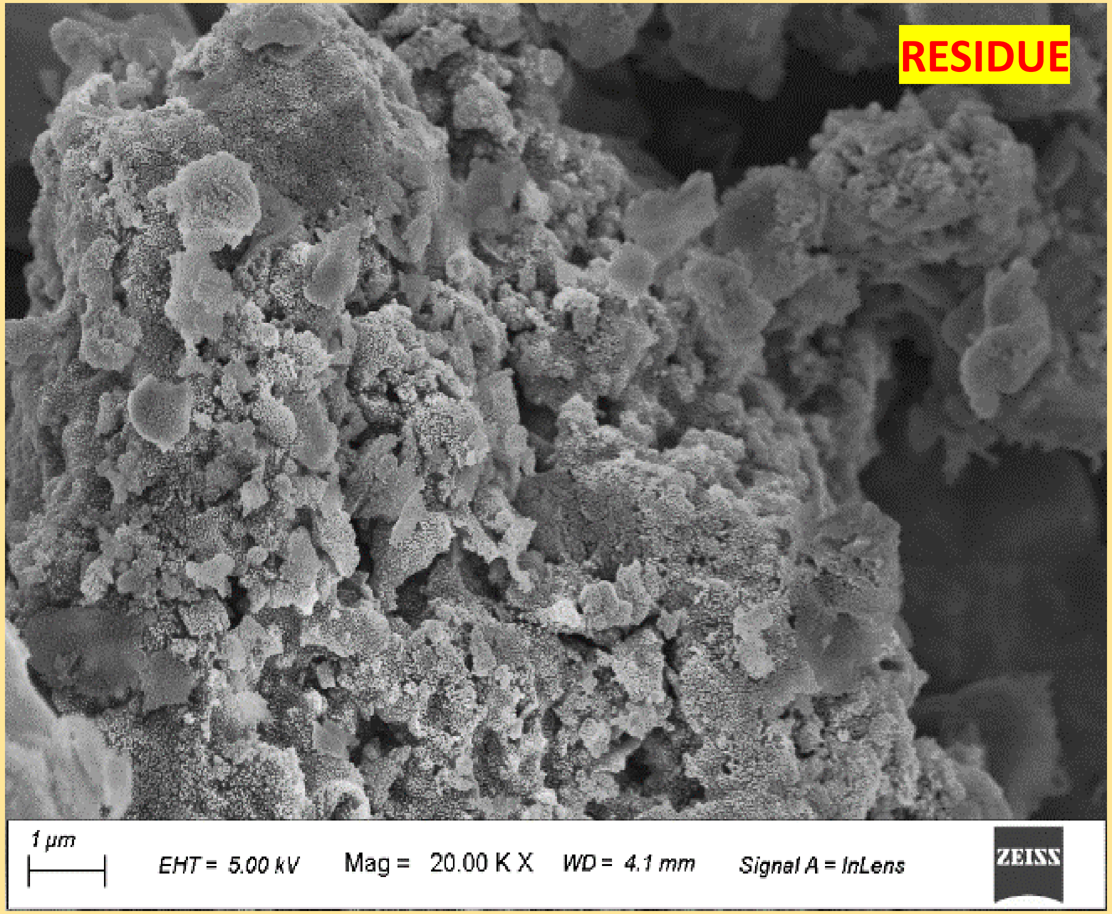




- Mixing EWP with HAC lowered the thermal decomposition temperature of HAC
- Thermal degradation mainly occurred in a single degradation step in EWP and HAC

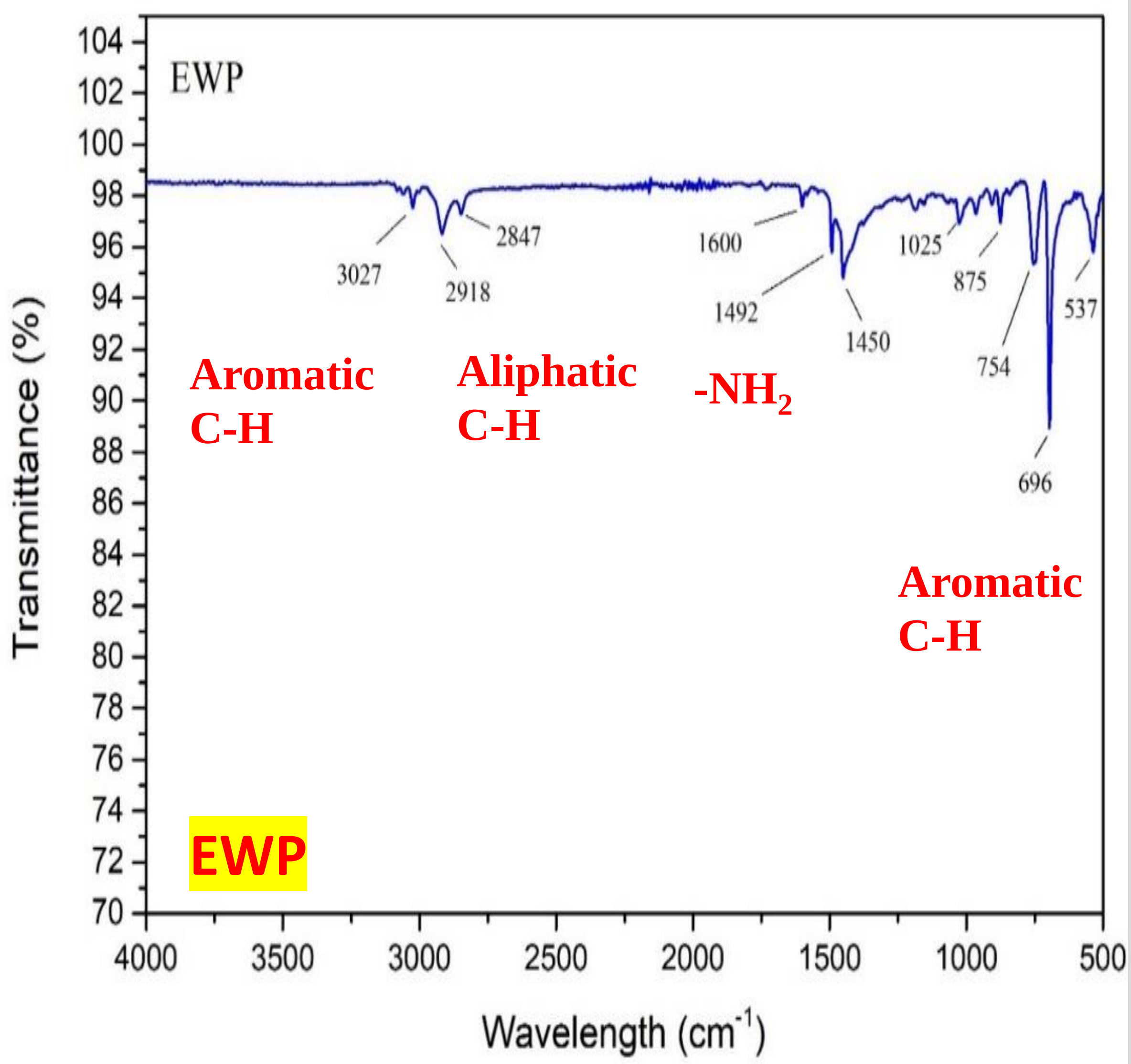
Field emission scanning electron microscopy (FESEM) analysis

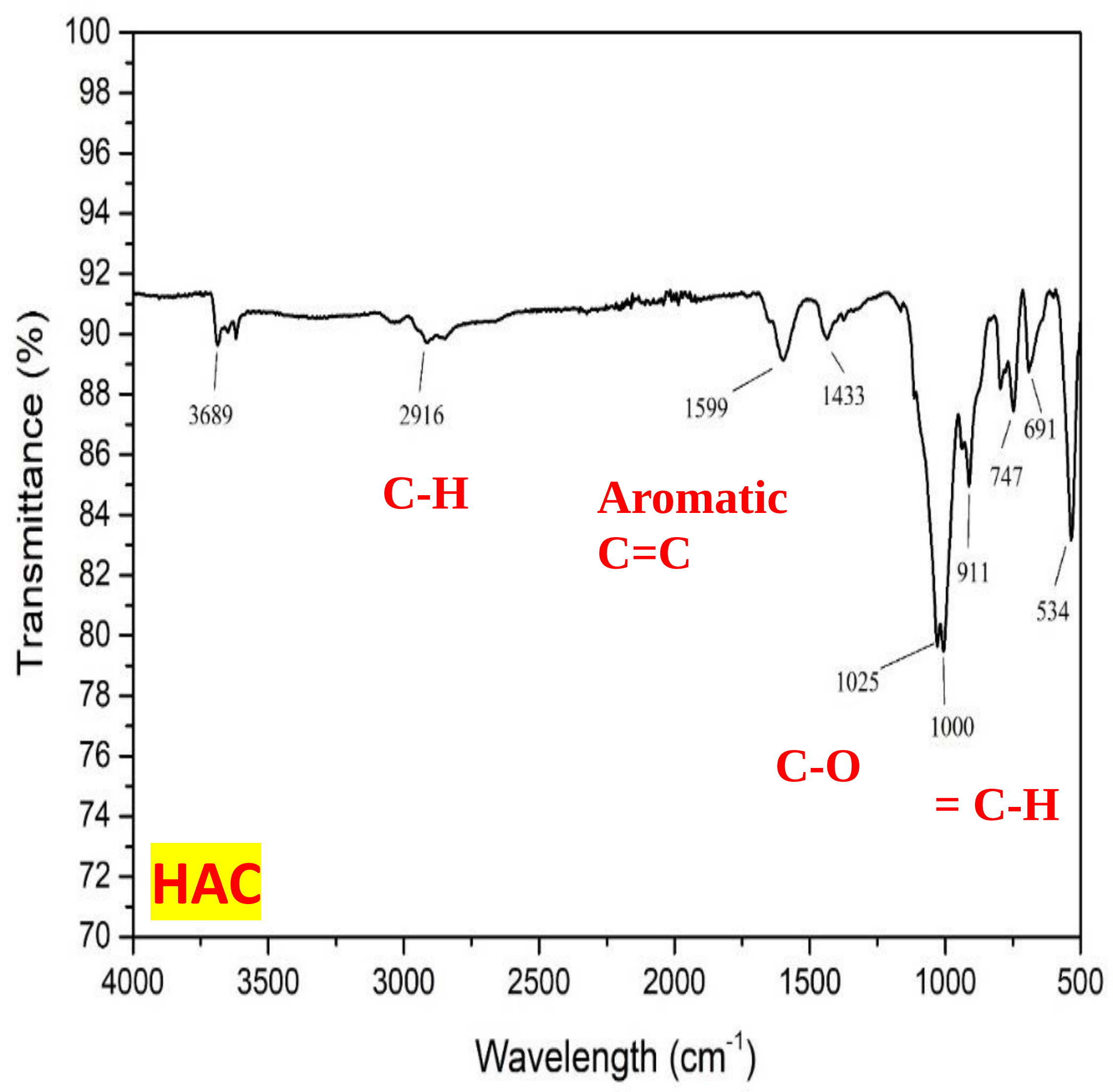




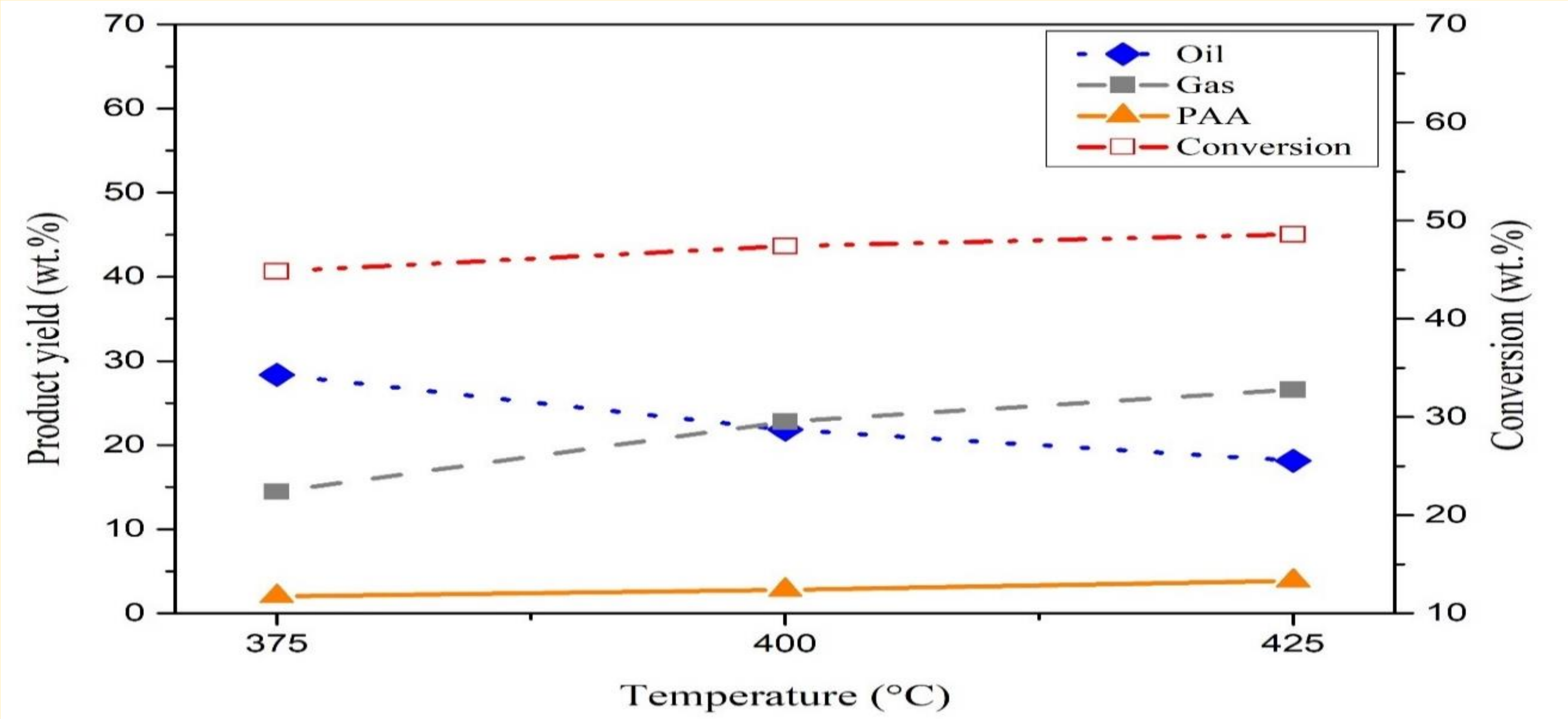
- **Disruption in the residue structure** as well as highly **increased pores** indicate thermal degradation and volatilization of feed samples

Fourier Transform Infrared (FT-IR) Spectroscopy analysis



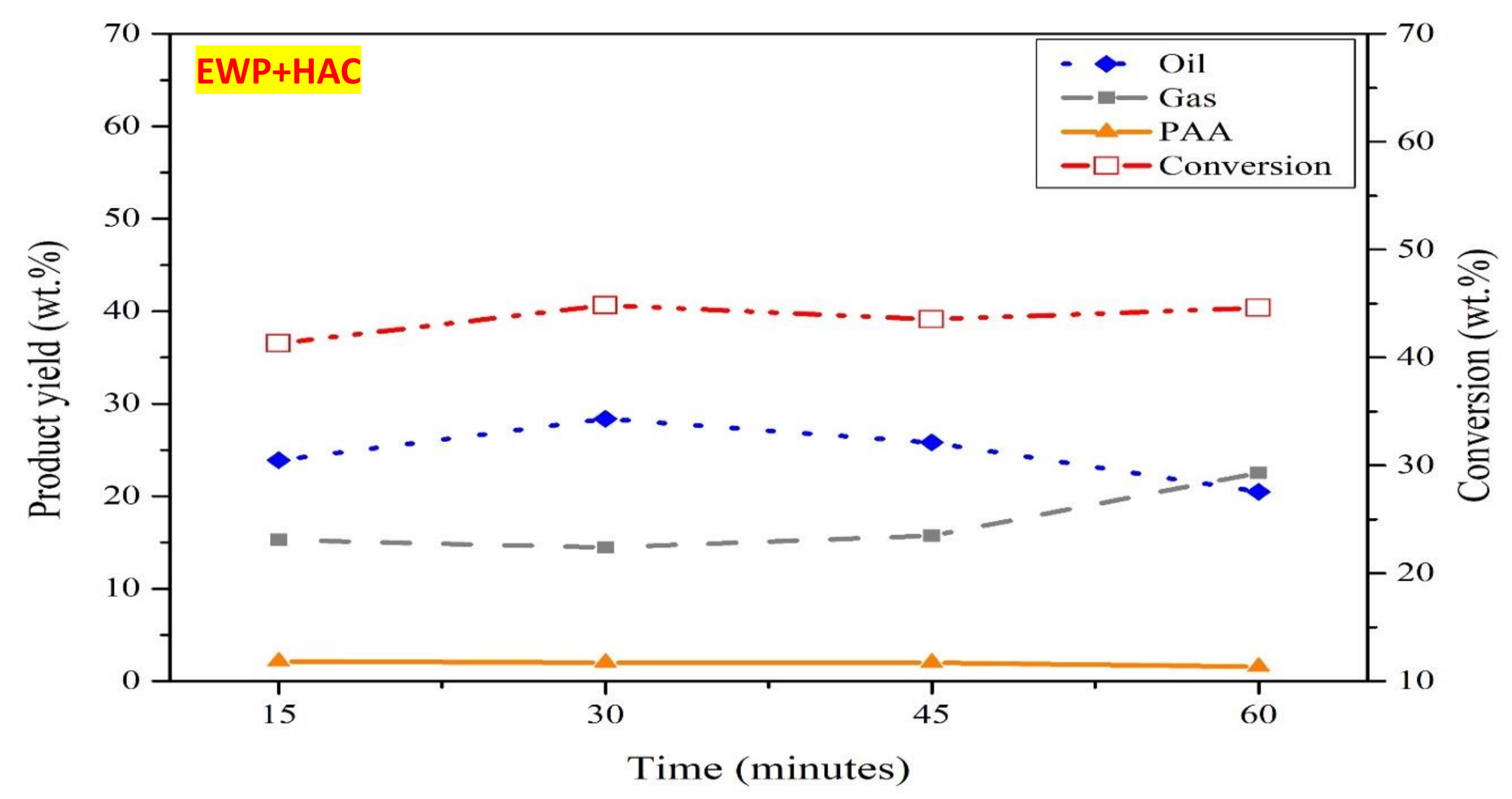


Effect of temperature on Co-liquefaction



- EWP+HAC co-liquefaction gave maximum oil yield of **28.37** wt.% during co-liquefaction at 375°C

Effect of time on Co-liquefaction



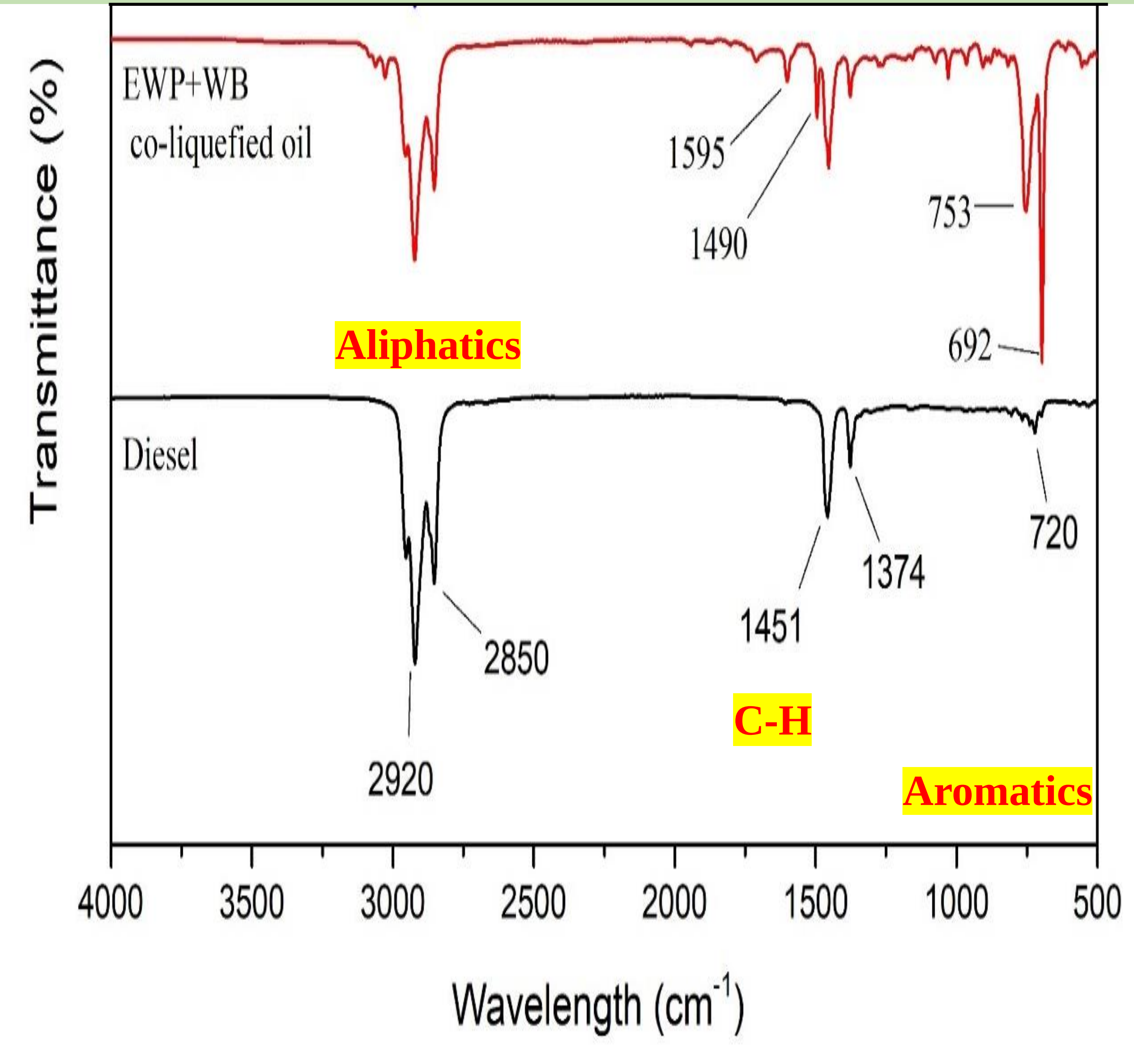
- Oil yield slightly increased till 30 minute then decreased and gas yield increased gradually with time

Fourier Transform Infrared (FT-IR) Spectroscopy analysis of Oil

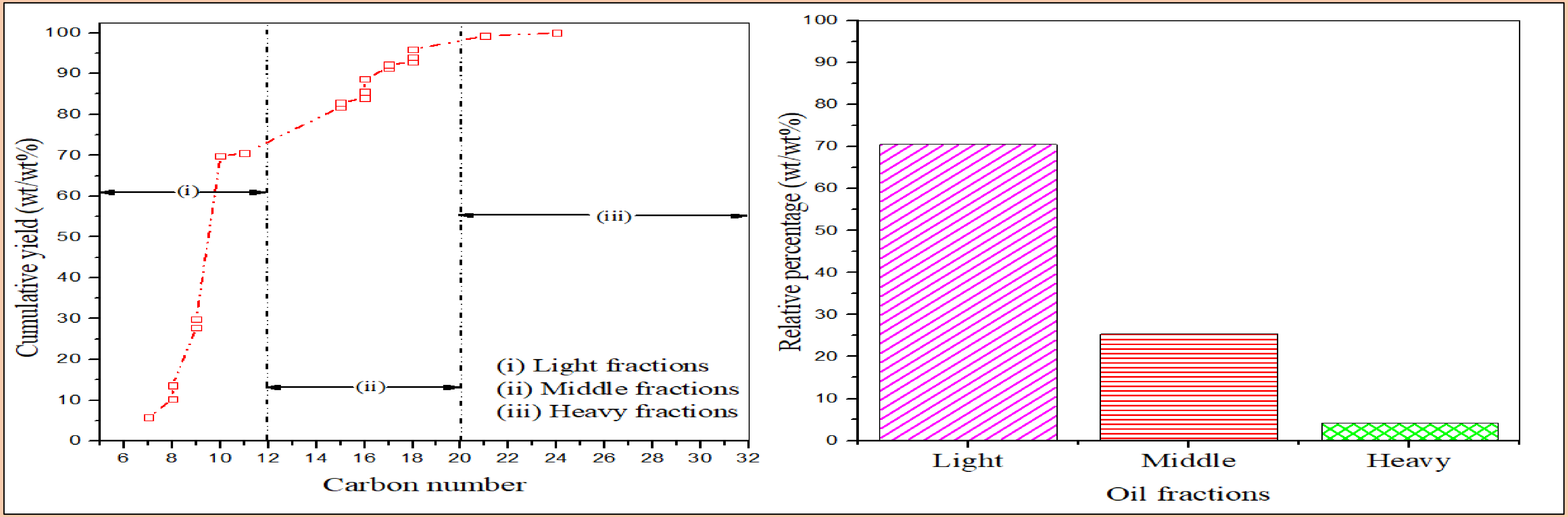
- **No water molecule or polymeric O–H** group (at 3200–3600 cm^{-1}) in oil samples

- High aromatic content in co-liquefied oil compared to diesel (peak at 692 cm^{-1})

- -C-H stretching (at 2920 cm^{-1}) and bending (1451 cm^{-1}) vibrations are identified in both co liquefied oil as in diesel (**alkanes** and **alkenes**)



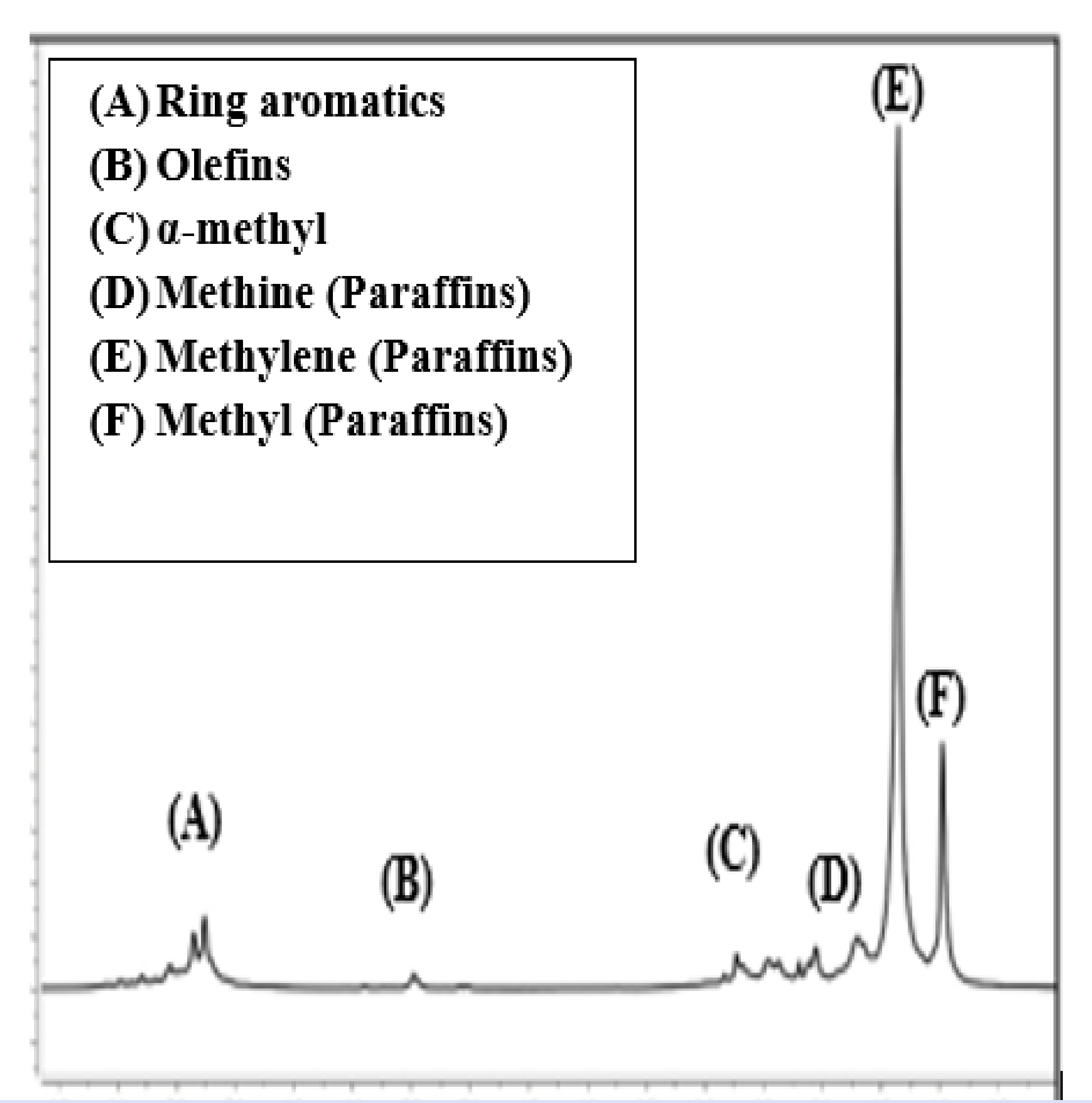
GC–MS analysis of the liquefied oil



- EWP+HAC co-liquefied oil showed higher light distillates (around **70.53%**)
- EWP+HAC liquefied oil has carbon chain length **C_7-C_{24}** and comparable to that of the diesel composition (**C_8-C_{25}**)

Nuclear Magnetic Resonance (^{1}H NMR) Spectroscopy Analysis

	Aromatics (v/v%)	Paraffins (v/v%)	Olefins (v/v%)
EWP liquefied oil	**61.06**	20.55	18.02
EWP+HAC co-liquefied oil	**31.32**	16.14	52.44
Diesel	**34.20**	**62.30**	**3.50**



Physical property comparison

	VISCOSITY (mPa-sec)	HHV (MJ/kg)
EWP liquefied oil	7.35	39.60
EWP+HAC liquefied oil	**4.05**	**40.15**
Diesel	**1.35**	**42-45**

Chemical property comparison

	C (%)	H (%)	N (%)	S (%)	O (%)	H/C	Reference
EWP liquefied oil	86.74	**8.77**	2.42	-	2.07	1.21	Present study
EWP+HAC liquefied oil	**87.02**	9.33	**1.25**	-	**2.40**	**1.29**	Present study
Bioethanol	**54.00**	14.49	0.23	0.71	**38.56**	3.22	Hansdah et al., 2013
Bio-diesel	**79.50**	10.30	1.3	-	**8.90**	1.55	Tutunea et al., 2019
Diesel	**86.00**	13.60	0.18	0.40	0	**1.89**	Hansdah et al., 2013

Conclusions

Oil contains lighter hydrocarbon compounds (C_7-C_{24}), comparable to that of the diesel composition (C_8-C_{25})

Oil quality (enhanced H/C ratio, paraffin content and **calorific value**)

Oil quality (reduced viscosity, aromatics and **oxygen content**)

Around 30% feed to oil conversion (higher calorific value 40.15 MJ/kg)


THANK YOU