

Appendix A. supplementary engineering information



Fig. A1 Practical application in (a) diesel-powered agricultural and (b) gasoline-powered agricultural equipment machinery



Fig. A2 Technology transfer and community-scale implementation of the developed single-pillar pyrolysis reactor. (a) Memorandum of Understanding (MOU) with local stakeholders. (b) Training in plastic waste management and pyrolysis technology. (c) Hands-on reactor operation. (d) Reactor installation and demonstration. (e–g) Community-scale deployment in Loei Province, Thailand.

Table A1 Distinguishing features of the proposed single-pillar pyrolysis system relative to commonly reported plastic-pyrolysis approaches.

Comparison criterion	Commonly reported approaches	Present study
Research emphasis	Optimization of operating conditions, product yield, or fuel properties	Integration of reactor development, engineering evaluation, and community-scale field validation
Reactor concept	Conventional fixed-bed, fluidized-bed, rotary-kiln, auger, or other laboratory per pilot configurations	Locally fabricated single-pillar batch reactor with an integrated vertical water-cooled condenser
Operating mode	Batch or continuous operation, depending on reactor design	Simplified batch operation suitable for decentralized use
Heat supply	Electricity, conventional fuels, or externally supplied process heat	External combustion using waste lubricating oil
Catalyst requirement	Thermal or catalyst-assisted operation	Catalyst-free thermal conversion
Feedstock	Frequently controlled, single-polymer, or model plastic feedstocks	Non-recyclable PP and PS mixtures representative of locally available plastic waste
Engineering evaluation	Commonly focused on product yield and selected fuel properties	Product distribution, PRE, FCE, heating-fuel consumption, oil productivity, residual solids, mass balance, HHV, and density
Experimental verification	Laboratory or pilot testing, with varying levels of replication	Replicated experiments and statistical comparison of selected feedstock conditions
Technology transfer	Infrequently integrated into reactor-performance studies	Operator training and reactor implementation in local communities
Field validation	Usually limited or conducted at a single experimental site	Practical operation and validation across 19 community sites
End-use assessment	Laboratory characterization or controlled engine testing	Practical use of recovered fuel in selected agricultural and community equipment
Principal contribution	Process or product optimization under controlled conditions	Integration of simplified reactor engineering with practical fuel utilization and multi-site community implementation

Table A2 Community-scale field validation of the developed single-pillar pyrolysis reactor in 19 local communities in Mueang Loei District, Thailand.

Community	Oil production (L day ⁻¹)	Solid residue (kg day ⁻¹)	PRE (%)	Plastic waste collected (kg day ⁻¹)	Plastic reduction (%)	Utilization of pyrolysis oil
Loei Municipality	24.5	2.73	90.90	150	20.00	Crematorium fuel
Na-or Municipality	23.5	2.54	91.53	80	37.50	Crematorium fuel; Agricultural engines
Na-an Municipality	20.5	2.35	92.17	55	54.55	Crematorium fuel; Agricultural engines
Na-pong Municipality	22.5	2.54	91.53	70	42.86	Crematorium fuel; Agricultural engines
Na-din-dam Municipality	23.5	2.05	93.17	65	46.15	Crematorium fuel; Agricultural engines
Nam-suai Municipality	24.0	1.98	93.40	60	50.00	Crematorium fuel; Agricultural engines
Mueang SAO	24.5	2.00	93.33	80	37.50	Crematorium fuel; Agricultural engines
Na-khaem SAO	23.0	2.15	92.83	65	46.15	Crematorium fuel; Agricultural engines
Kok-du SAO	21.5	1.85	93.83	50	60.00	Crematorium fuel; Agricultural engines
Kok-thong SAO	20.5	1.85	93.83	50	60.00	Crematorium fuel; Agricultural engines
Chaiyapruet SAO	25.0	2.00	93.33	60	50.00	Crematorium fuel; Agricultural engines
Nam-man SAO	24.0	2.30	92.33	50	60.00	Crematorium fuel; Agricultural engines
Si Song Rak SAO	20.5	2.10	93.00	60	50.00	Crematorium fuel; Agricultural engines
Nam-suai SAO	21.5	1.95	93.50	60	50.00	Crematorium fuel; Agricultural engines
Siao SAO	23.5	2.05	93.17	50	60.00	Crematorium fuel; Agricultural engines
Mueang Loei District Office	24.5	1.85	93.83	30	100.00	Crematorium fuel
Ban Kamnoet Phet Community	20.5	2.00	93.33	30	100.00	Crematorium fuel; Agricultural engines
Loei Anukulwittaya School	23.5	2.00	93.33	30	100.00	Brush cutter
Loei Rajabhat University	25.0	1.85	93.83	100	30.00	Crematorium fuel; Agricultural engines
Mean ± SD	22.97 ± 1.61	2.12 ± 0.25	92.96 ± 0.87	55.79 ± 29.95	55.51 ± 22.41	

Note: PRE = Plastic reduction efficiency; SAO = Subdistrict Administrative Organization (Thailand).