

Strategic Analysis of Waste Tire Recycling Technologies

Thermal Pyrolysis and the EET Valorisation Strategy

Technical pyrolysis challenges, EU compliance requirements and the commercial valorisation strategy for the resulting products.



Key challenges of thermal tire pyrolysis



Waste tires have variable compositions and contain inherent impurities — sulfur, chlorine and multiple inorganic mineral phases. Accurate temperature control is essential to minimise oil contamination in recovered carbon black (rCB).



Crude tire pyrolysis oil (TPO) suffers from high sulfur content, organic-chlorine residues, low aromaticity and a significant proportion of heavy fractions above 343 °C. Hydro-treatment is required to meet refinery feed specifications. Vapour residence-time governs product distribution, and fine filtration is needed to remove solid particulates.



Raw rCB has 8–16 wt% ash. Some mineral impurities cannot be removed by simple acid-alkali washing. Pyrolysis damages rCB's reinforcing carbon-black structure; hence rCB can only partially replace virgin tire-grade carbon black.



The EET approach uses proven three-stage pyrolysis technology. After purification, de-ashed rCB (ash < 5 wt%, particle < 76 µm) is steam-activated to produce commercial activated carbon with an iodine value > 750 mg/g.



Crude TPO is purified and distilled at a 343 °C cut-point into light (LTT) and heavy (HTT) fractions. HTT can be blended with anthracene oil for oil-furnace carbon-black production. LTT may go directly to refineries or receive optional hydro-treatment to remove organic metals, chlorine and sulfur. Non-condensable gas supplies the process's internal heat needs.



All products must comply with relevant EU regulations: carbon black meets ASTM D1765, ISO 2556 and REACH rules; activated carbon follows REACH (EC 1907/2006) and CLP (EC 1272/2008). ISCC Plus certification is available for circular-economy traceability.

Applicable EU standards

Carbon Black N330, N660

- ASTM D1765
- ISO 2556
- REACH Annex II (EU 2020/878)
- PAHs content under REACH Annex XVII

Activated Carbon

- REACH (EC 1907/2006)
- CLP (EC 1272/2008)

ISCC Plus Certification

Circular-economy traceability across all products derived from pyrolysis.

Recycling waste tires through pyrolysis

Raw Materials

Different compositions depending on tire type.

Impurities such as zinc sulfide (ZnS), zinc oxide (ZnO), zinc orthosilicate (Zn_2SiO_4), silicon dioxide (SiO_2), aluminosilicates, calcium-magnesium sulfides/silicates/sulfates, iron(II) sulfide (FeS), iron(III) oxide (Fe_2O_3), as well as minor alkali-metal salts and chlorine and sulfur present in the rubber.

Pyrolysis Process

Temperature control is decisive for the composition of both TPO and rCB, particularly in limiting the contamination of rCB by organic oil.

Challenges related to tire pyrolysis oil (TPO)

High sulfur content

Thermal pyrolysis oil contains a high sulfur content (mainly thiophenic sulfur). Without catalytic cracking, high-molecular-weight sulfur compounds are abundant. Deep hydrodesulphurization is essential for uses such as refinery feedstock, BTX production or SAF additives, which raises operating costs.

Organic chlorine residues (tens to hundreds of ppm)

Organic chlorine mainly comes from the chlorinated butyl rubber in the inner liners. Thermal decomposition only partially releases HCl; organochlorinated aromatic compounds remain in the oil. Water washing only removes inorganic chlorides. Residual chlorine causes catalyst poisoning and equipment corrosion downstream.

Low aromaticity, large share of heavy fractions

Compared with catalytic pyrolysis, thermal pyrolysis oil has a much lower aromatic content and contains substantial heavy oligomers boiling above 343 °C. Complex and unstable, it limits direct use as fuel. Heavy fractions are used for carbon black, while light fractions require complex upgrading.

High sensitivity to vapour residence time

A prolonged residence time intensifies secondary thermal cracking; too short a residence time leaves an excess of heavy oligomers. Industrial processes require precise residence-time control to balance yield and product composition. Entrainment of fine rCB particles in the oil requires high-temperature fine filtration.

Challenges related to recovered carbon black (rCB)

High ash content, limited removal efficiency

Raw rCB has an ash content of 8–16 wt% (ZnS, ZnO, zinc orthosilicate, silica, aluminosilicates, calcium-magnesium sulfides/silicates/sulfates). Dilute acid-alkali washing only removes ZnS and ZnO; zinc orthosilicate and aluminosilicates are chemically recalcitrant. Combined grinding and washing cannot meet the ash specification ($\leq 0.5\%$) of virgin N330-type carbon black.

Thermal damage to reinforcing aggregate structures

Original carbon-black aggregates sinter and agglomerate under pyrolysis; DBP absorption declines. Grinding only breaks up macroscopic agglomerates without rebuilding the original branched network. Reinforcement performance in rubber is markedly lower than virgin carbon black: rCB is only suited to partial substitution in tread formulations.

Residual sulfur and trace chlorine

Sulfur is present as inorganic sulfides and organically-bound sulfur within rCB. Trace organic chlorine also remains, negatively affecting the rubber's vulcanization behaviour.

A proven, industrialised technology

TARGET

Turn pyrolysis process outputs into standard commercial products.

STRATEGY — Build on mature technologies

■ Three-stage pyrolysis process

This technology has been used in China for more than 4 years for waste tire pyrolysis. It produces rCB with very low organic-oil contamination, thanks to precise temperature control at each stage.

■ Activated carbon production via steam activation

The rCB is purified to remove oxides and silica (ash < 5%), then granulated to < 76 μm . Steam activation produces activated carbon with an iodine value reaching > 750 mg/g — a level suitable for commercialisation.



Distillation and carbon black production

Distillation Process

Purification: removal of solid particles present in the oil.

Separation of LTT and HTT with a 343 °C boiling-point cut-off.

Carbon Black Production (Oil-Furnace Process)

Using heavy tire-derived pyrolysis oil (HTT).

HTT can be blended with anthracene oil to produce marketable carbon black.

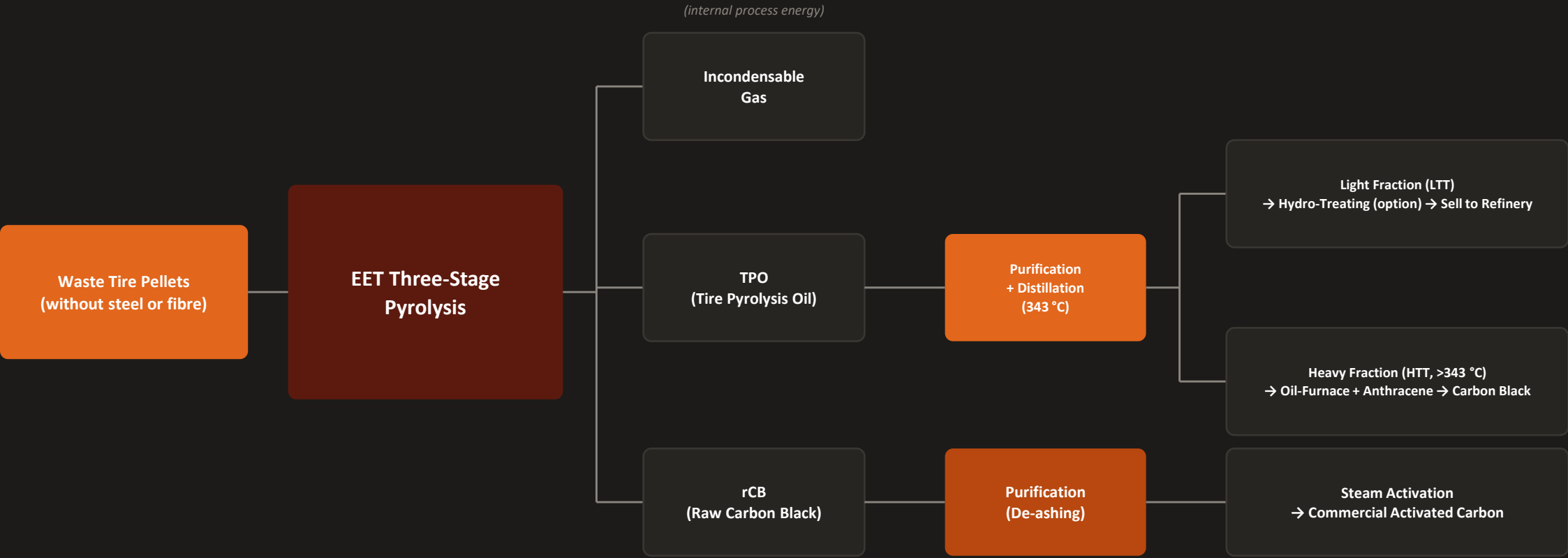
LTT: a feedstock meeting refinery standards

LTT can be sold directly to refineries, or hydro-treated to remove metals, chlorine and sulfur — particularly in organic form. The resulting products can then be sold as steam-cracking feedstock. The standards accepted by major refiners are summarised below.

Item	Unit	ExxonMobil	Shell	Total	BP	Chevron	General Industry Ref.	Sinopec
Total Chlorine	mg/kg	≤ 10	≤ 5-10	≤ 10	≤ 10	≤ 10	≤ 10	≤ 10
Silicon	mg/kg	≤ 3	≤ 1-3	≤ 3	≤ 3	≤ 3	≤ 3	≤ 3
Total Metals (Fe+Ca+Na+K...)	mg/kg	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5
Water Content	wt%	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Sulfur	mg/kg	≤ 100	≤ 100	≤ 100	≤ 100	≤ 100	≤ 100	≤ 100
Nitrogen	mg/kg	≤ 400	≤ 200-400	≤ 400	≤ 400	≤ 400	≤ 400	≤ 400
Oxygen	mg/kg	≤ 100	≤ 50-100	≤ 100	≤ 100	≤ 100	≤ 100	≤ 100
Bromine Number	gBr ₂ /100g	≤ 20	≤ 15-20	≤ 20	≤ 20	≤ 20	Report	Report
Mechanical Impurities	—	No visible sediment (all sources)						
Density at 20 °C	g/cm ³	0.78-0.85	0.78-0.85	0.78-0.85	0.78-0.85	0.78-0.8	0.78-0.85	0.78-0.85
Distillation Range	—	C5-C30, heavy-end fractions strictly controlled (all sources)						

RECOMMENDED PROCESS

EET's Three-Stage Pyrolysis Process



The process turns a single waste stream into three valuable outputs — internal energy, refinery-grade purified oil, and carbon (carbon black or activated carbon) — under a specification controlled end to end.

Thank You

Let's discuss how this three-stage pyrolysis technology can fit into your valorisation project.

Quick contact

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**THREE-STAGE
PYROLYSIS**