

SawitEcoFlex RUBBER PROCESSING OIL

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Currently, the global rubber industry is heavily dependent on petroleum-based rubber processing oils, particularly aromatic oils [e.g., distillate aromatic extract (DAE) and treated distillate aromatic extract (TDAE)], which are associated with polycyclic aromatic hydrocarbons (PAHs), compounds linked to carcinogenic risks have raised increasing regulatory and environmental concerns (Zhang et al., 2025). Concurrently, the growing availability of palm-based resources and the rising demand for sustainable rubber solutions highlight the need for innovative, high-performance alternatives (Sovtić et al., 2020). Accordingly, there is a clear need for safe and more sustainable rubber processing oils (RPOs) that can replace conventional petroleum-based RPOs without compromising performance. Such alternatives must not only meet stringent processing and mechanical requirements but align with environmental regulations while advancing the value proposition of palm-based materials (Hayichelaeh & Boonkerd, 2023).

SawitEcoFlex RPO is a high-performance bio-based RPO developed primarily from palm derived feedstocks with renewable content up to 95% (Figure 1). It is designed as a drop-in

replacement for conventional petroleum-based RPOs, including paraffinic, naphthenic, and aromatic oils. The technology is designed to deliver comparable or superior processing performance while significantly enhancing occupational health and safety, reducing exposure to hazardous constituents, and improving environmental sustainability. In this context, SawitEcoFlex aligns with multiple Sustainable Development Goals (SDGs).

Key trends driving the transition towards SawitEcoFlex RPOs include:

- Increasing global regulatory pressure (e.g., EU REACH restrictions on PAHs).
- Rising demand for sustainable and bio-based materials.
- Strengthening Environmental, Social, and Governance (ESG) commitments from tyre manufacturers and rubber product industries.
- Volatility in petroleum prices and supply chains.

The market opportunity for bio-based RPO is elaborated in Figure 2. The global RPO market is a multi-billion-USD industry, with strong growth driven by the expansion of green tyres, eco-rubber, and sustainable manufacturing practices. This is



Figure 1. SawitEcoFlex rubber processing oil (RPO).

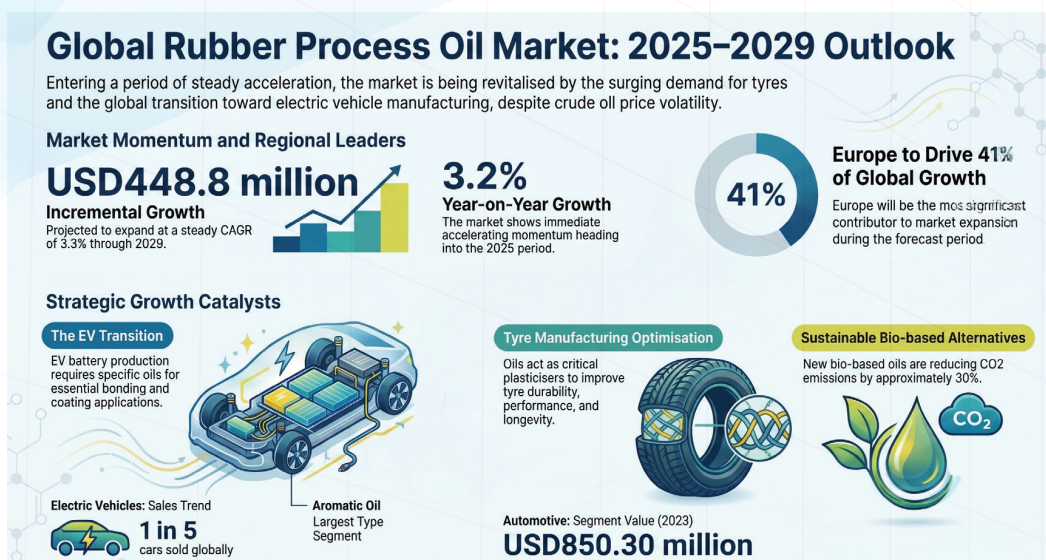
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Source: Technavio (2026).

Figure 2. Global rubber processing oil (RPO) market 2025-2029.

further supported by the increasing adoption of bio-based alternatives, particularly in Asia and Europe, where regulatory frameworks and industry commitments are accelerating the transition towards safer and more sustainable RPOs.

THE TECHNOLOGY

Objectives

SawitEcoFlex RPO is designed to redefine rubber processing by combining high performance with sustainability, offering a practical pathway for industries to transition away from petroleum-based inputs without compromising efficiency or product quality.

- Develop an RPO that matches or surpasses the performance of conventional petroleum-based oils.
- Eliminate or significantly reduce PAH content, ensuring safer rubber products and improved regulatory compliance.
- Provide a drop-in solution that is fully compatible with existing rubber compounding processes, requiring no process modifications.
- Support the transition toward low-carbon, environmentally responsible rubber manufacturing.
- Unlock high-value downstream applications for palm oil derivatives, strengthening economic returns within the oleochemical sector.

Methodology

The development of SawitEcoFlex RPO follows a structured process to ensure high performance and industrial readiness:

- **Formulation Development**
Develop and optimise SawitEcoFlex RPO formulations to achieve targeted processing and performance characteristics.
- **Characterisation**
Analyse key properties to ensure quality and consistency.
- **Compounding and Benchmarking**
Incorporate the RPO in rubber compounds and benchmark performance against TDAE and other conventional oils to assess processability and compatibility.
- **Performance Evaluation**
Evaluate final rubber properties to ensure they meet or exceeds industry requirements.

NOVELTY OF THE TECHNOLOGY

SawitEcoFlex RPO distinguishes itself as a next-generation RPO by combining high renewable content with advanced formulation strategies, delivering both performance and sustainability. By integrating palm-based chemistry into high-performance applications, it addresses

critical industry challenges related to health, compatibility, and process integration (Figure 3). Key features include:

- Ultra-High Renewable Content**
 Contains up to 95% bio-based content, significantly higher than most partially bio-based alternatives.
- Safer Formulation**
 Engineered with low-to-zero PAH content, directly addressing critical health and environmental concerns.
- Tailored Molecular Design**
 Customised molecular structure enhances compatibility across a wide range of rubber systems.
- True Drop-in Solution**
 Fully compatible with existing processing infrastructure, requiring no changes in formulation or equipment.
- Advanced Palm-based Integration**
 Elevates palm-derived materials into high-performance applications, creating a new value-added pathway for the oleochemical industry.

BENEFITS AND ADVANTAGES

SawitEcoFlex RPO matches the performance of TDAE, paraffinic, and naphthenic oils while

providing superior processability, enhanced filler dispersion, and improved elasticity and durability of rubber products, along with thermal and oxidative stability. It prevents exposure to carcinogenic PAHs, is biodegradable, and contributes to a lower carbon footprint, aligning with sustainability goals. Additionally, it integrates seamlessly into existing equipment, formulations, and manufacturing workflows, enabling easy adoption without operational disruption.

ECONOMIC ANALYSIS AND COMMERCIALISATION POTENTIAL

SawitEcoFlex RPO presents strong economic and commercial potential, with its economic analysis based on a production capacity of 2,000 t/yr using blending facilities (Table 1). It offers competitive pricing with petroleum-based oils at scale while enabling premium positioning for green-labelled products. The technology targets high-demand sectors such as tyre manufacturing, industrial rubber goods, and automotive components (Sampath et al., 2025). Market opportunities are particularly strong in Europe and the USA due to stringent regulatory frameworks, as well as in the Asia-Pacific region, which accounted for approximately 46.7% of the market share in 2024. Besides, its scalability is further supported by the abundant availability of raw materials in Malaysia and Indonesia, as well as seamless integration into existing palm oil supply chains.

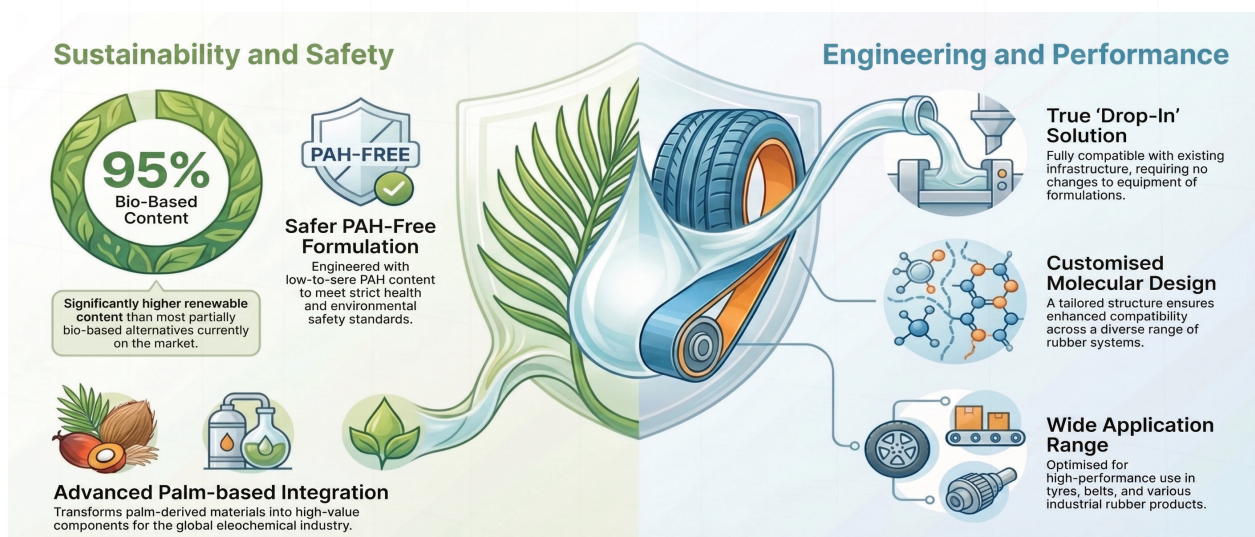


Figure 3. Novelty of the SawitEcoFlex rubber processing oil (RPO).

TABLE 1. CALCULATED BASED ON THE PRODUCTION CAPACITY OF 2,000 t/yr OF SawitEcoFlex RUBBER PROCESSING OIL USING THE BLENDING FACILITIES

Economic analysis	Value
Net present value (NPV) @ 10%	RM33,388,585.00
Discounted payback period	3 years
Discounted benefit-cost ratio (BCR)	1.26
Return of investment (ROI), %	26.47

Note: Calculated based on a discounted rate of 10%.

IMPACT

SawitEcoFlex RPO drives the transition toward more sustainable rubber manufacturing by supporting SDG commitments and advancing circular economy practices. It enhances the value of downstream palm-based products while unlocking new revenue opportunities within the oleochemical sector. At the same time, it reduces reliance on fossil-based inputs, lowering carbon emissions and enabling safer disposal with minimised ecological toxicity.



IP STATUS

This technology is protected under a trade secret - MPOB RD 016/2024.

CONCLUSION

SawitEcoFlex RPO represents a next-generation rubber processing oil that bridges performance, safety, and sustainability. By offering a bio-based, low-PAH, and fully compatible alternative, it directly addresses the pressing challenges in the rubber industries, particularly those related to health, processing efficiencies, and material

compatibility. Its demonstrated commercial viability, scalability, and alignment with regulatory frameworks position it as a strategic solution for the future of green rubber manufacturing.

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