

# Bio-based Polysaccharide Alkyd Resin for low VOC Marine Protective Paint

INDONESIA

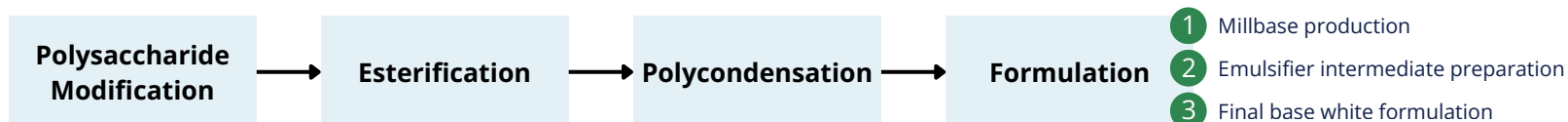
**Key Concepts-** Low VOC; alkyd resin; polysaccharide alkyd resin; bio-based materials; sustainable coatings

## Central Problem

Alkyd resins are widely used in marine painting coatings due to their excellent film-forming ability, good adhesion to metal substrates, and moderate resistance to weathering. In marine environments, Base White Alkyd Resin is typically applied as a primer or topcoat on steel structures to provide initial protection against corrosion and environmental degradation. However, the conventional formulation and production process of alkyd resins pose significant environmental concerns, especially when applied in large-scale maritime operations. Therefore, there is a critical need to develop alternative resin systems that reduce VOC emissions, eliminate hazardous substances, and utilize renewable resources, without compromising coating performance and durability.

## Potential Solution

Sigma Utama, a paint manufacturer, proposes a bio-based polysaccharide alkyd resin derived from starch or cellulose and fatty acids as a sustainable alternative to conventional high-VOC alkyd systems.

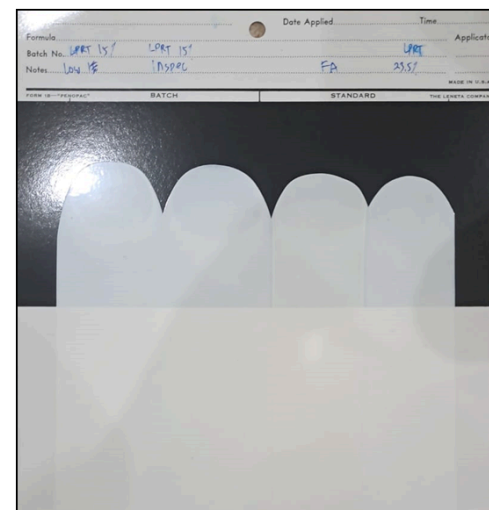


**Fig 1.** Process Flow of Polysaccharide Alkyd Resin for Base White Formulation

The formulation is using water as the primary carrier instead of organic solvents, which significantly reduces VOC emissions and eliminates the need for toxic additives such as heavy-metal driers. Due to the higher polarity and hydrophilicity of polysaccharide-modified resins, a multi-step (batching) process is required. By separating pigment dispersion, emulsification, and final formulation, the process ensures stable emulsions and prevents flocculation.

**Table 1.** Comparative Assessment: Conventional Alkyd vs Polysaccharide Alkyd

Aspects	Conventional Alkyd	Polysaccharide Alkyd
Raw Material	Petroleum-based	Bio-based (starch/cellulose + fatty acids)
Primary Carrier	Solvent (high VOC)	Water (low VOC)
Additives	Heavy metal-based driers (e.g., cobalt, lead), classified as POPs	Not required
Production Process	Single-step (Simpler)	Multi-step batching process
Performance	Good	Shows promising opacity and visual appearance



**Fig 2.** Opacity Test and Visual Appearance of Polysaccharide Alkyd



## Impact Assessment Analysis

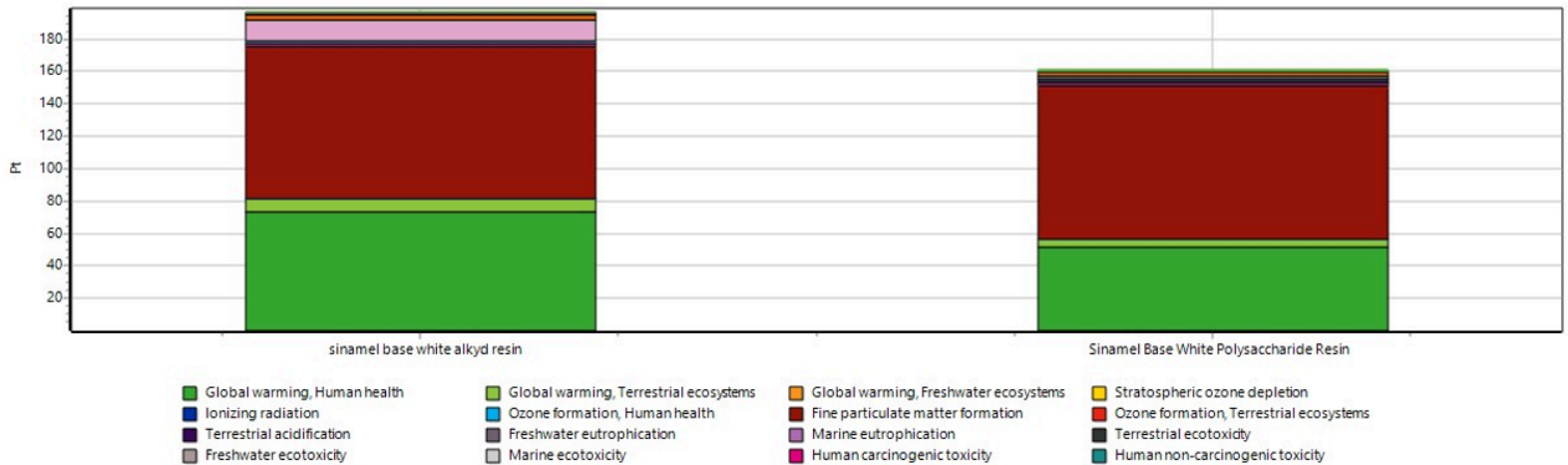


Fig 3. Comparison of Impact Categories: Conventional Alkyd Resin vs Polysaccharide Alkyd Resin

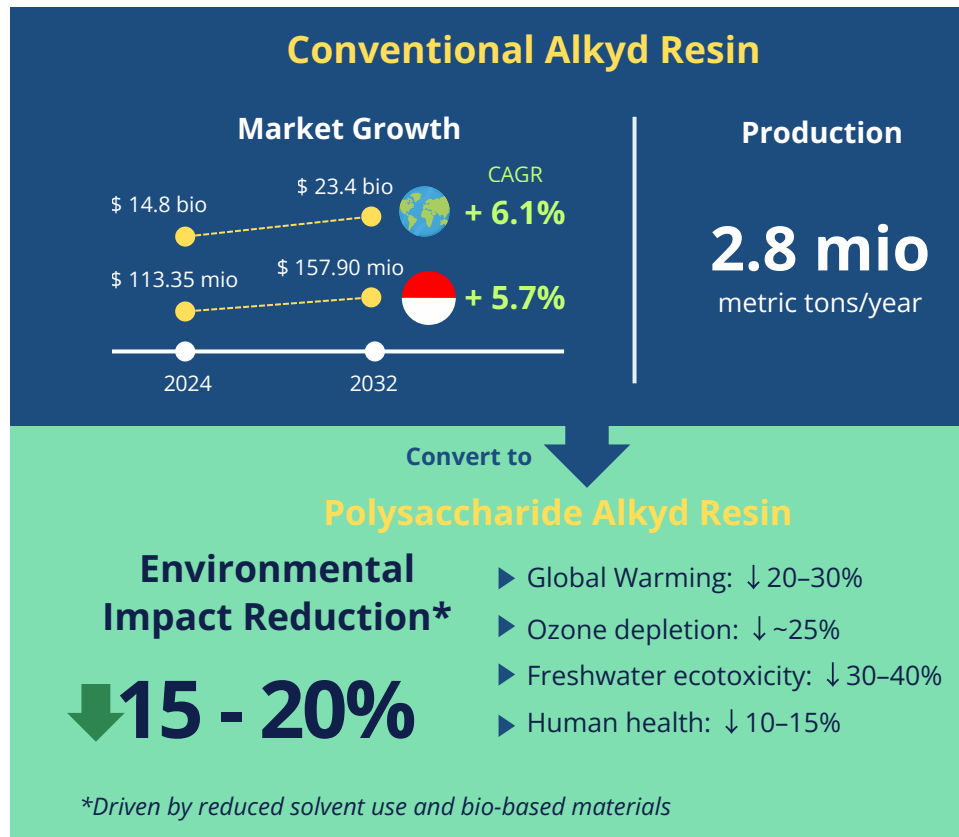
The life cycle assessment (LCA) shows that the polysaccharide alkyd resin reduces overall environmental impact by approximately 15–20% compared to conventional alkyd formulations. This improvement is mainly driven by the significant reduction in solvent use and the replacement of high-impact petroleum-based materials. The system also demonstrates notable decreases in key impact categories, including global warming (20–30%), ozone depletion (~25%), and freshwater ecotoxicity (30–40%). From a damage perspective, impacts on human health decrease by around 10–15%, while ecosystem damage shows a substantial reduction of up to 60%. Although the polysaccharide binder becomes a new hotspot, the overall results confirm that the polysaccharide route delivers broad environmental benefits without significant trade-offs, making it a more sustainable alternative for coating production.

## Lesson Learned/Key Takeaways

- 1 Environmental gains are driven by solvent reduction**  
The transition significantly lowers overall environmental impact, mainly by reducing solvent use and eliminating high-impact petroleum-based alkyd resin.
- 2 New hotspots identified from LCA require further optimization**  
While overall impacts decrease, the polysaccharide binder and pigment contribution remain significant, highlighting the need for material selection and formulation optimization.
- 3 Further validation for performance and scalability**  
Ongoing work will focus on formulation optimization and extended performance testing, including durability (UV exposure), chemical resistance, mechanical strength, and surface properties, to ensure suitability for protective applications and support scale-up.



## Market Relevance



The alkyd resin market is a large and growing segment of the coatings industry. At this scale, reliance on petroleum-based, high-VOC systems results in significant environmental impact across the value chain.

LCA results show consistent reductions across key environmental impact categories, confirming the polysaccharide route as a more sustainable alternative. Shifting even a fraction of this demand to bio-based polysaccharide alkyd resins could:

- Reduce VOC emissions across the coatings sector
- Decrease reliance on fossil-based raw materials
- Eliminate hazardous additives (e.g., cobalt, lead driers)
- Enable new value chains based on renewable biomass