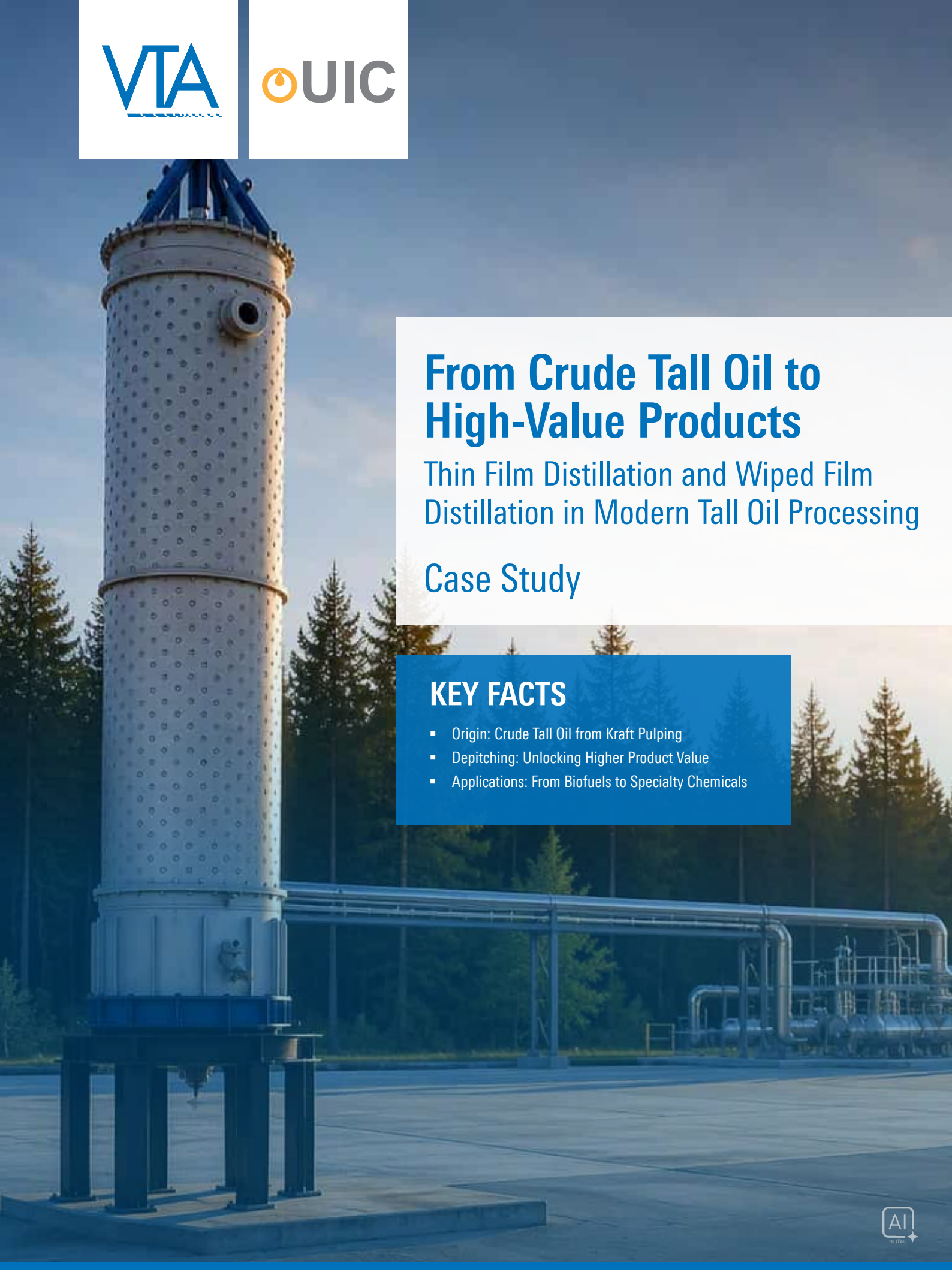


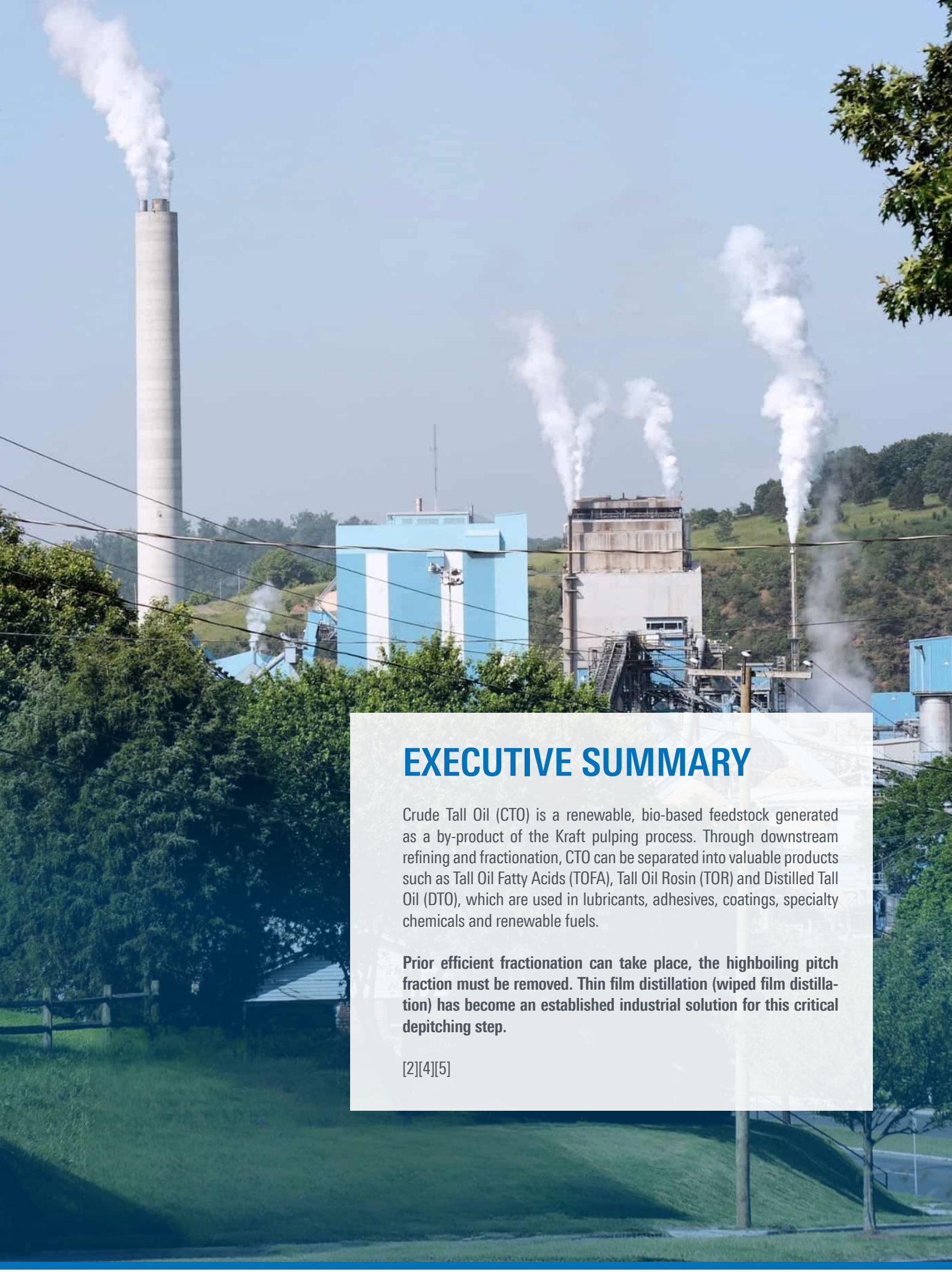
From Crude Tall Oil to High-Value Products

Thin Film Distillation and Wiped Film Distillation in Modern Tall Oil Processing

Case Study

KEY FACTS

- Origin: Crude Tall Oil from Kraft Pulping
- Depitching: Unlocking Higher Product Value
- Applications: From Biofuels to Specialty Chemicals



EXECUTIVE SUMMARY

Crude Tall Oil (CTO) is a renewable, bio-based feedstock generated as a by-product of the Kraft pulping process. Through downstream refining and fractionation, CTO can be separated into valuable products such as Tall Oil Fatty Acids (TOFA), Tall Oil Rosin (TOR) and Distilled Tall Oil (DTO), which are used in lubricants, adhesives, coatings, specialty chemicals and renewable fuels.

Prior efficient fractionation can take place, the highboiling pitch fraction must be removed. Thin film distillation (wiped film distillation) has become an established industrial solution for this critical depitching step.

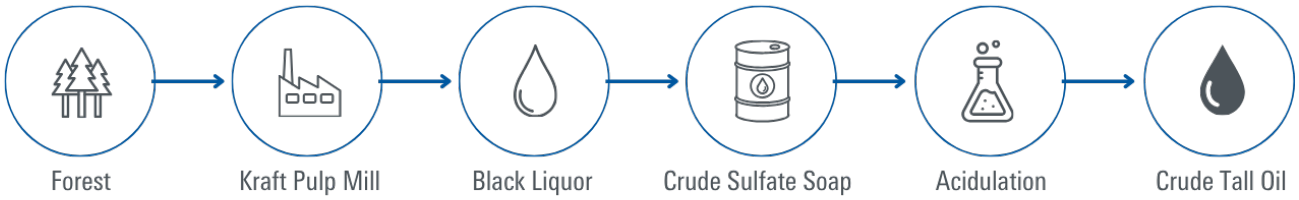
[2][4][5]

Crude Tall Oil

A Valuable Renewable Feedstock

From Forest to Crude Tall Oil

Tall oil originates from the Kraft pulping process, the dominant technology for the production of chemical pulp from softwood species. During pulping, naturally occurring extractives such as fatty acids and rosin acids react with the alkaline pulping liquor and form sodium soaps. These soaps accumulate in the black liquor and can be recovered as crude sulfate soap. The recovered crude sulfate soap is subsequently acidulated with sulfuric acid, converting the sodium salts into free organic acids and producing Crude Tall Oil (CTO). [5]



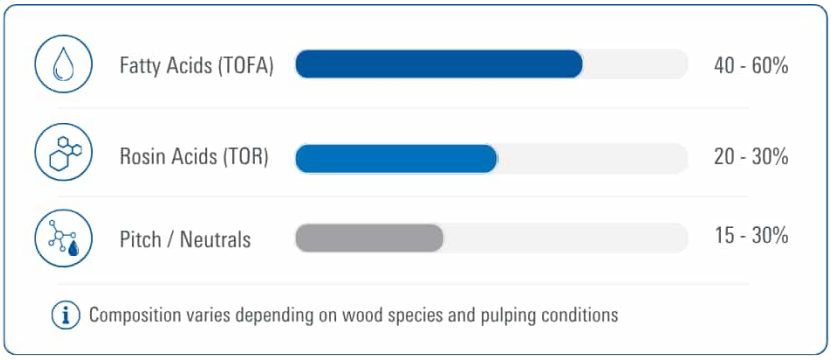
A Complex Mixture of Valuable Components

Crude Tall Oil is not a single compound but a complex mixture of several valuable component groups. The exact composition depends on wood species, pulping conditions and mill operation. [4][5]

Typical CTO fraction:

- Tall Oil Fatty Acids (TOFA)
- Tall Oil Rosin (TOR)
- Distilled Tall Oil (DTO)
- Tall Oil Pitch (TOP) [2,3]

Crude Tall Oil Composition (typical)



Values shown represent indicative ranges reported in the literature and may vary depending on wood species, pulping process and operating conditions.
Sources: New Zealand Institute of Chemistry [5]; Niemeläinen (2018) [4].

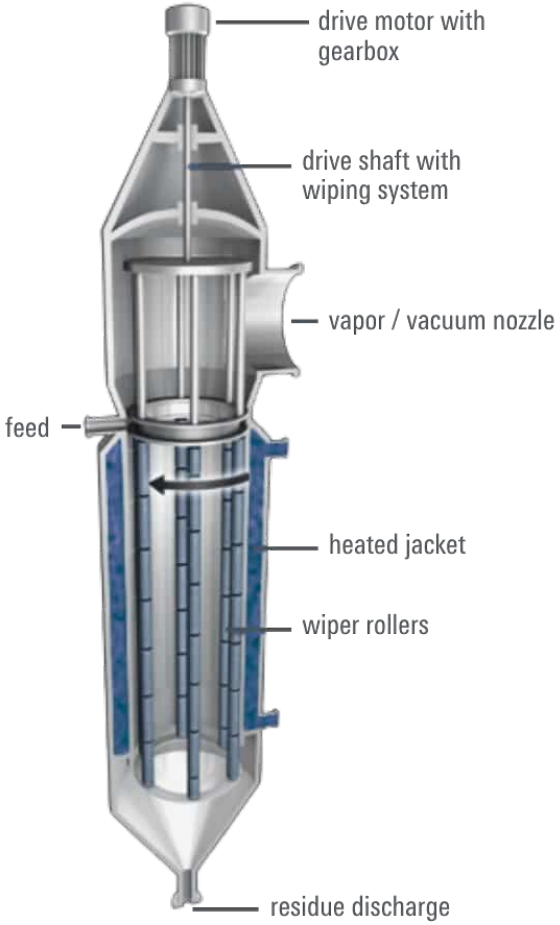
Depitching by Thin Film Distillation / Wiped Film Distillation

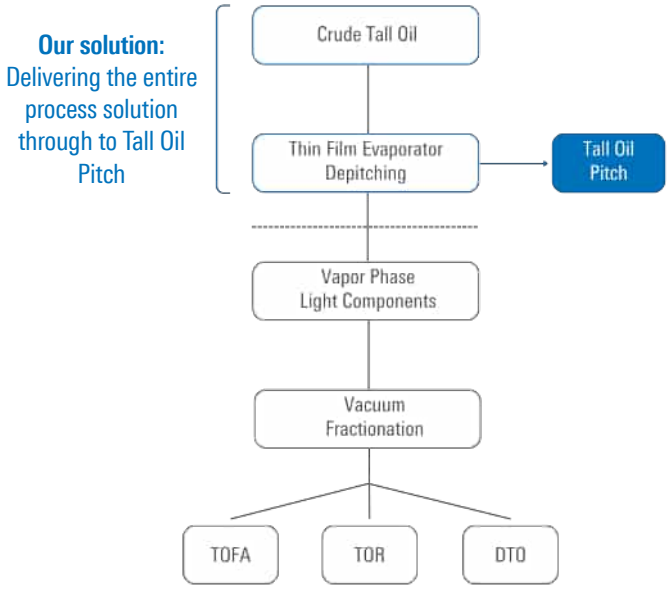
Tall Oil Pitch (TOP) represents the highest-boiling fraction, modern CTO refining schemes typically include a dedicated depitching step before further vacuum fractionation and production of commercial tall oil products. If pitch is not removed before fractionation, deposits can form in downstream distillation equipment, potentially reducing operational reliability and product quality. [4][5]

High Evaporation Rates within a Single Process Path

Thin film evaporators (wiped film evaporators) consist of a cylindrical heating jacket and an inner rotating wiper system, distributing the product on the inner evaporator plate as a thin and turbulent film. The turbulence in the thin film increases the heat and mass transfer to achieve a high evaporation rate at short residence times. The vapours are either condensed on an external condenser or further separated in a fractional column.

Thin film evaporation (wiped film evaporation) allows reliable processing of heat-sensitive, fouling and viscous tall oil streams, even at high throughput rates.





Source: Niemeläinen (2018) [4]; NZIC [5],
Adapted from the dry distillation concept discussed by Niemelainen (2018).

Thin Film Evaporation / Wiped Film Evaporation Under Demanding Process Conditions

The depitching step in tall oil processing is a complex thermal separation operation. Equipment must reliably handle:

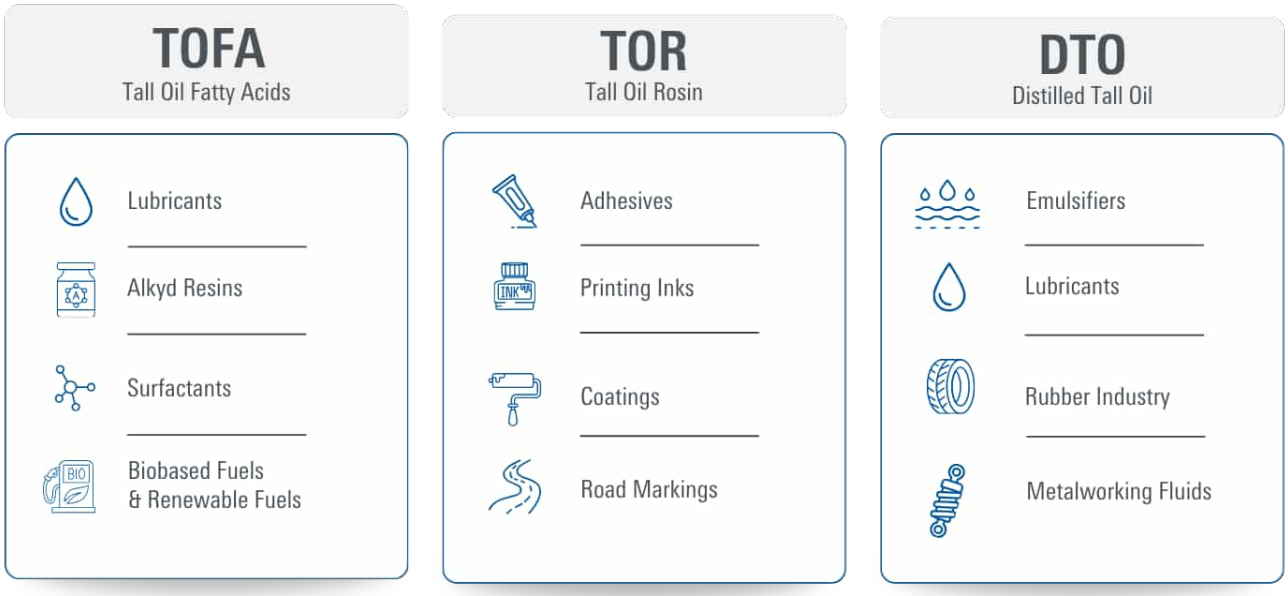
- High throughputs
- Elevated operating temperatures
- Viscous process streams
- Organic-acid-containing process streams
- Continuous 24/7 operation [4]

Special Metallurgy

Due to its high corrosion resistance, AISI 904L (EN 1.4539) is widely used for product-wetted components in tall oil processing applications [8]. Manufacturing large-scale equipment from this highly alloyed material requires advanced fabrication capabilities and stringent quality control procedures. Our expertise enables the cost-effective production of large thin film evaporators (wiped film evaporators) and pressure vessels in EN 1.4539, combining process reliability with long service life.

Enabling High-Value Tall Oil Products

Following depitching, CTO is further processed through vacuum fractionation into several valuable product streams. [5]



Sources: [1], [2], [3], [5]

Growth Driven by Renewable Fuels

Crude tall oil (CTO) is increasingly valued as a renewable feedstock for bio-based products and renewable fuel applications. [3]
As a by-product of the Kraft pulping process, it offers a favorable sustainability profile and does not require dedicated agricultural land. Growing demand and limited availability make efficient utilization of CTO increasingly important. [1][2]
Regardless of the final product slate, the removal of tall oil pitch remains a critical processing step. Efficient depitching is required to enable reliable downstream fractionation and recovery of valuable CTO-derived products. [4][5]

Beyond Depitching: Future Valorization of Tall Oil Pitch

Traditionally, Tall Oil Pitch has been regarded as the heavy residue produced during CTO fractionation. However, increasing attention is being paid to the valuable components still present within this stream. Tall Oil Pitch contains an unsaponifiable neutral fraction including phytosterols and other neutral compounds. Several patented industrial processes explicitly describe the recovery of sterol-rich fractions from Tall Oil Pitch. [4][6][7]
For example, EP2252675 states: „The invention especially relates to the separation of the sterol neutral substances by means of high vacuum distillation/evaporation." [6]
Similarly, WO2022117922 describes: „The separation of the sterol neutral substances from tall oil pitch (TOP) by means of distillation or evaporation." These developments demonstrate that Tall Oil Pitch may represent not only a residue stream, but also a potential source of future value creation. [6][7]
While the focus of this case study is CTO depitching rather than sterol recovery, the presence of valuable compounds in Tall Oil Pitch further highlights the importance of efficient pitch handling and separation. [4][6][7]

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