



**Converting Secondary or
Waste Oil into Biodiesel via
the Enzymatic Way**

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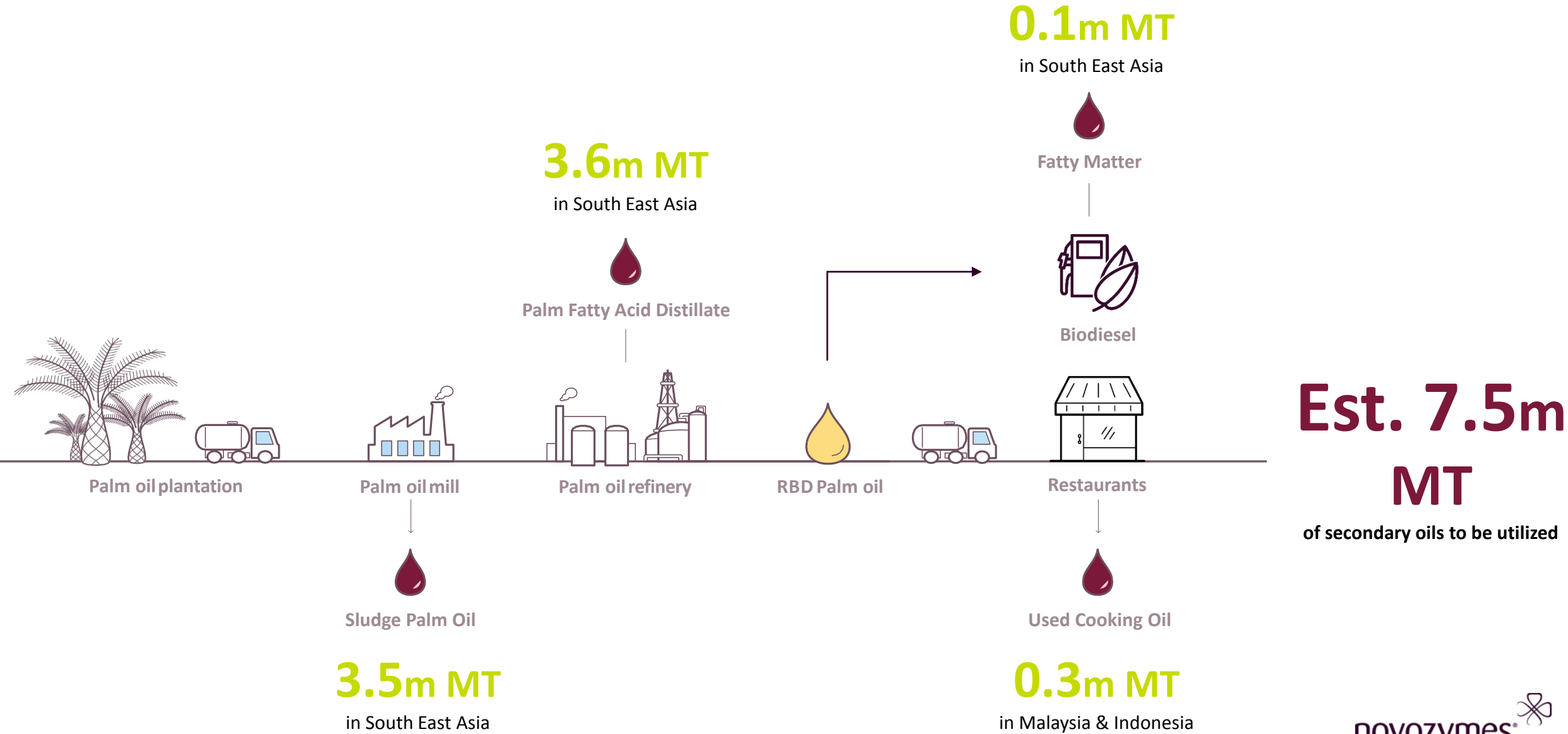
3 KEY MESSAGES

Better
Businesses
with **Biology**



- 1 Secondary or waste oil - where and how they impact us
- 2 Enzyme technology to handle flexible feedstock
- 3 Comparison with other processing routes

Sources of Secondary or Waste oil



What if They are Going Back Into The Food Chain?

The New York Times

EDITORIAL

Taiwan's 'Gutter Oil' Scandal

By [The Editorial Board](#)

Sept. 18, 2014

Since Sept. 4, the Taiwanese authorities have been struggling to control a food scare caused by 645 tons of adulterated cooking oil produced by the Chang Guann Company and distributed to more than 1,200 restaurants, schools and food processors. As of Monday, health authorities had identified a wide array of more than 1,300 food products tainted by the oil, including instant noodles, snacks, cakes, dumplings, bread, canned pork, meat paste and glutinous rice. Taiwan obviously needs a stronger food-safety policy with meaningful penalties.

New York Times-18 Sep 2014

3-MCPDe issue

“Palm oil is mechanically extracted and the extraction efficiency is about 92%. Some of the balance of 8% can be recovered and recycled. By right, this oil should be sold separately as technical grade palm oil. But if you emphasise high OER, mills with low OER will recycle it,”

“What can be done to reduce the level of 3-MCPDE and GE? Estates need to send in fresh fruits free of debris and mills need to stop recycling recovered oil, and remove chlorides from the water used in the milling process, Ng says.”

The Edge Markets MY-13 Mar 2018

What if Biodiesel Demand Increases?

REUTERS Business Markets World Politics TV M

COMMODITIES DECEMBER 23, 2019 / 1:32 PM / 2 MONTHS AGO

Indonesia launches B30 biodiesel to cut costs, boost palm oil

Bernadette Christina 3 MIN READ

JAKARTA (Reuters) - Indonesia on Monday launched biodiesel containing 30% palm-based fuel, the highest mandatory mix in the world, in a bid to slash its fuel import bill and boost domestic palm oil consumption.

Reuters 22 Dec 2019

MALAYSIA CORPORATE POLITICS & GOVERNMENT

NAP 2020

Malaysia to implement B30 biodiesel mandate in transport sector before 2025

Reuters / Reuters February 21, 2020 11:25 am +08

Malaysia's Prime Minister, Ismail Sabri Yaakob, is shown speaking at a podium during a press conference. He is wearing a dark suit and a patterned tie. The Malaysian flag is visible in the background.

The Edge Markets MY-21 Feb 2020

B10 biodiesel introduced in Thailand

June 20, 2019

The first public sale of PTT UltraForce Diesel B10 biodiesel in Thailand has been officiated by Energy Minister Siri Jirapongphan, *Petrol Plaza* reported on 30 May.

Thailand was promoting B10 biodiesel as the main diesel fuel to replace the current B7 biodiesel by 2021.

The country was offering an excise tax discount of 1 baht (US\$0.03)/litre for B10 biodiesel, to encourage drivers to make the switch.

The ministry anticipated that the introduction of B10 biodiesel would raise palm oil consumption from 1.5M tonnes/year to 2M tonnes/year, *Pattaya Mail* reported.

There were currently 1,600 PTT petrol stations in Thailand, *Petrol Plaza* said.

A close-up photograph of a yellow fuel nozzle being inserted into a fuel tank. The nozzle is connected to a hose, and the fuel tank opening is visible.

OFI 20 June 2019

More secondary or by-products generated...

Sustainability?

People Start Looking Into Solutions

QSR to turn oil waste into biofuel

BUSINESS

Monday, 04 Mar 2019
12:00 AM MYT

By ERIC QUAH

QSR Brands restaurants division CEO Merrill Christopher Pereyra (left), FatHopes Energy CEO and founder Vinesh Sinha (right) exchanging documents after the signing of a memorandum to adopt waste to energy practice on a commercial scale. With them is QSR Brands managing director Datuk Seri Mohamed Azahari Mohamed Kamil (center).

KUALA LUMPUR: QSR Brands (M) Holdings Bhd, the operator of KFC and Pizza Hut restaurants, has signed a memorandum of agreement (MoA) with fuel conversion company FatHopes Energy Sdn Bhd to deploy sustainable practices and eco-friendliness in its operations by processing cooking oil waste into biofuel.



“The other method—**enzymatic transesterification**—makes use of an enzyme called lipase to catalyze the **conversion of UCO into UCOME**. This can be done even in acidic environments, thus eliminating the need for the neutralization pre-treatment step. No further chemicals are added, so the cost of wastewater treatment is kept to a minimum. “

“This is part of our corporate social responsibility, to ensure that our used cooking oil are not consumed by Malaysians, because **we do not want these oils to be sold in the black markets to the unsuspecting public,**”
The Star, 4th March 2019

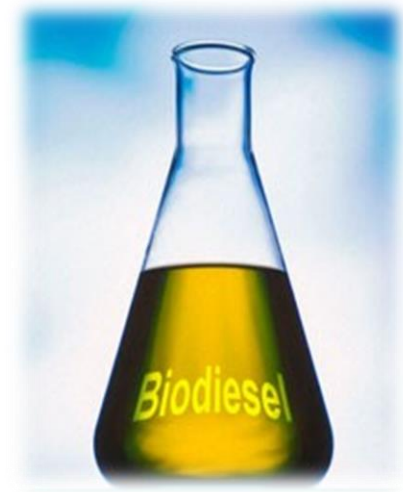
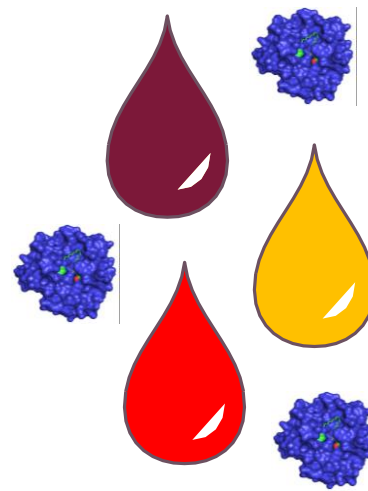
Asian Scientist 5th December 2019
<https://www.asianscientist.com/2019/12/features/aswp2019-gutter-gold/>

Turning these waste oils into biofuel could be one of the best options.



Quality of secondary or waste oil varies and is difficult to control, while enzymes are forgiving and

FLEXIBLE



ENZYMATIC BIODIESEL

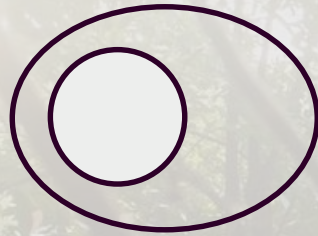
Enzymes are nature's problem solvers

Natural



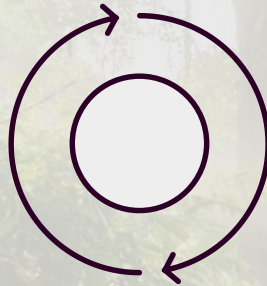
Enzymes are nature's tools – they speed up vital biological processes

Proteins



Enzymes are proteins present in all living cells. For example, they help digest foods

Catalytic



Enzymes are catalysts – enabling milder processes and saving energy and water

Specific



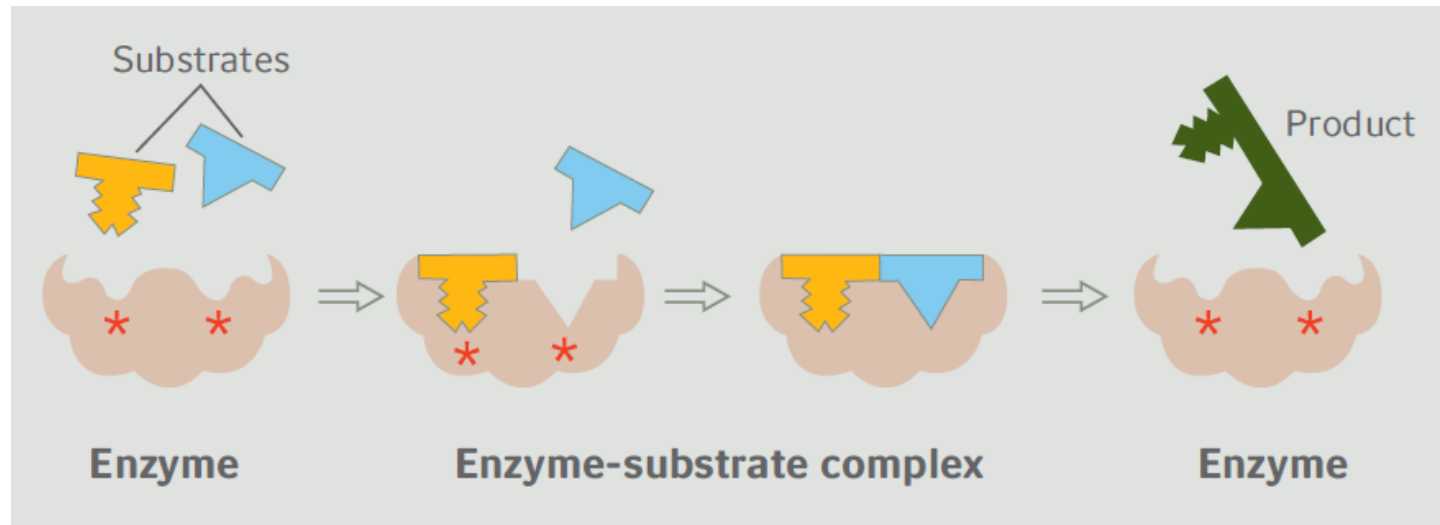
Enzymes are highly specific in their reactions and the substrates they target

Biodegradable

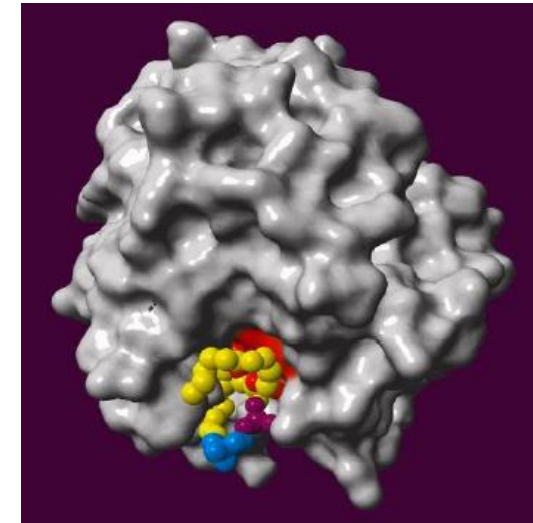


Enzymes are fully biodegradable and break down to harmless amino acids

Biodiesel Process Chemistry: Enzymatic Reaction

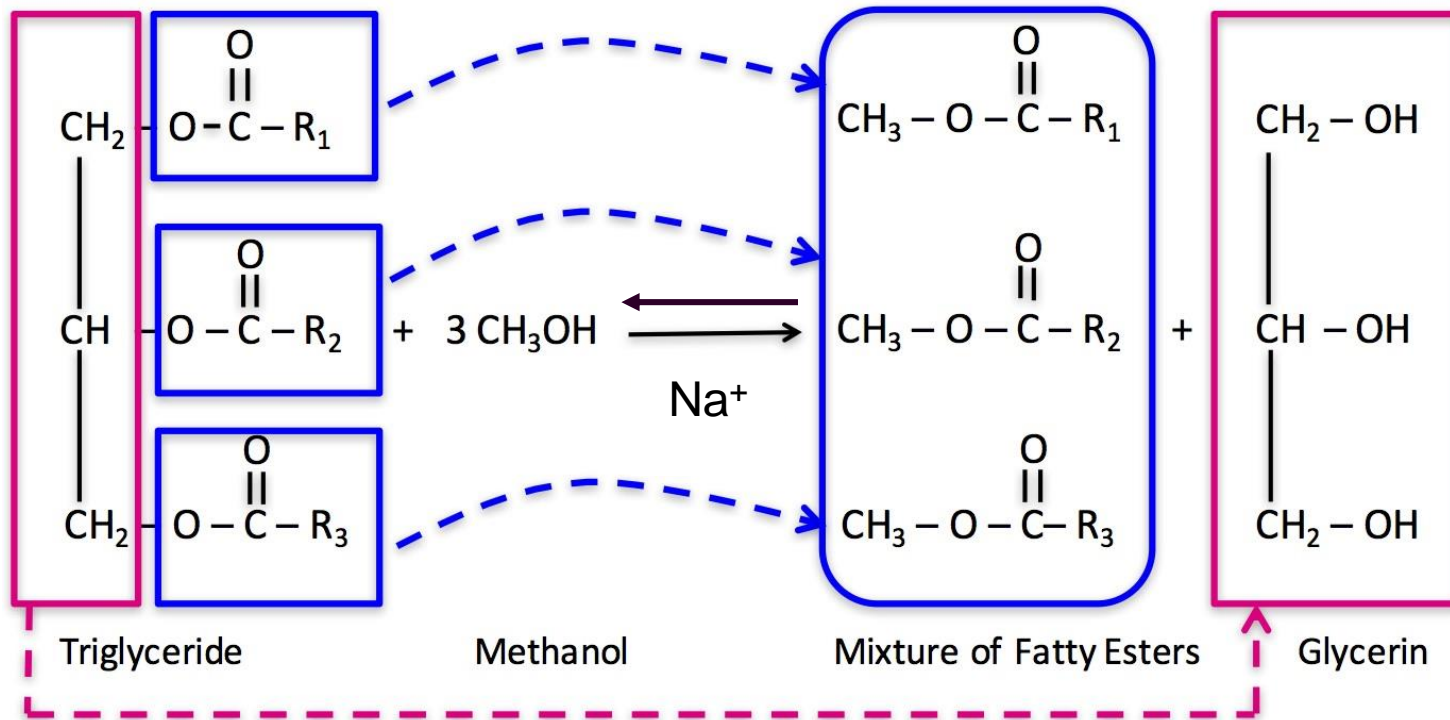


Lock and Key Model of Enzymatic Catalysis



Enzyme & Substrate

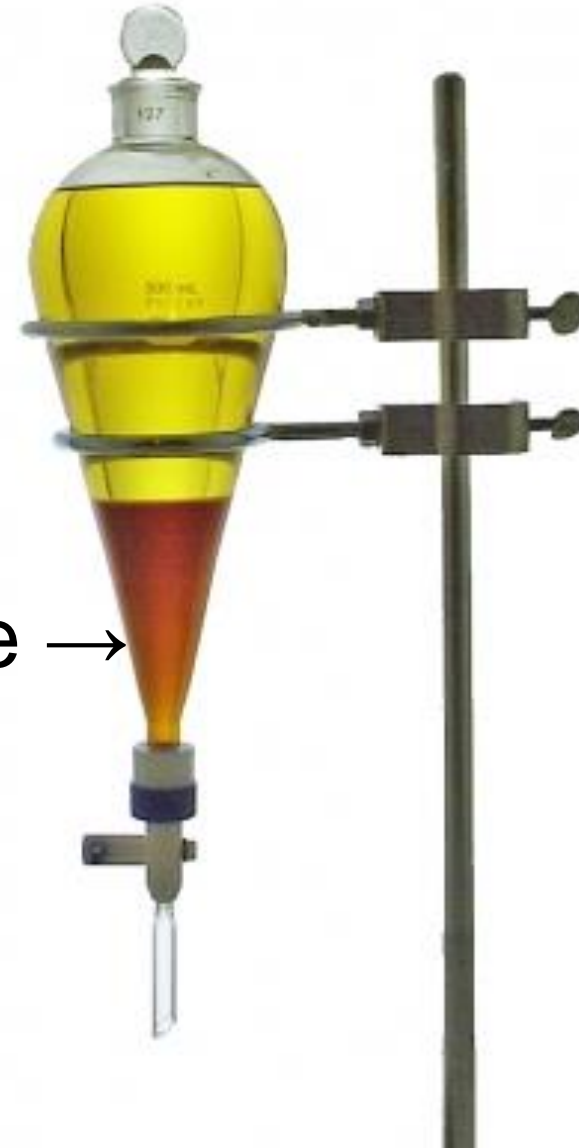
Biodiesel Process Chemistry: Classical Transesterification



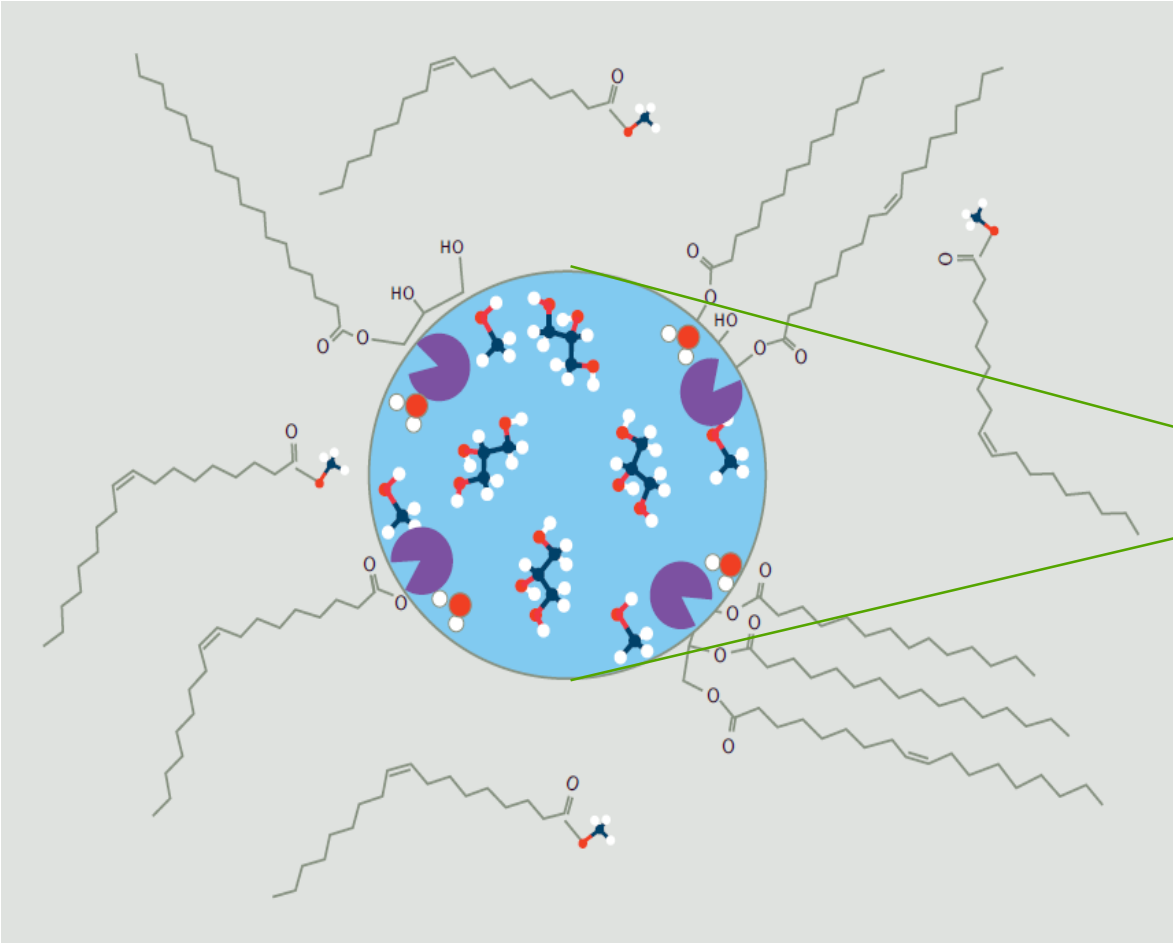
Note: Triglyceride = RBD Palm Oil
Note: FAME = Fatty Acid Methyl Ester

FAME →

Glycerine →



Enzymatic Reaction Between the Interaction of Light Phase and Heavy Phase



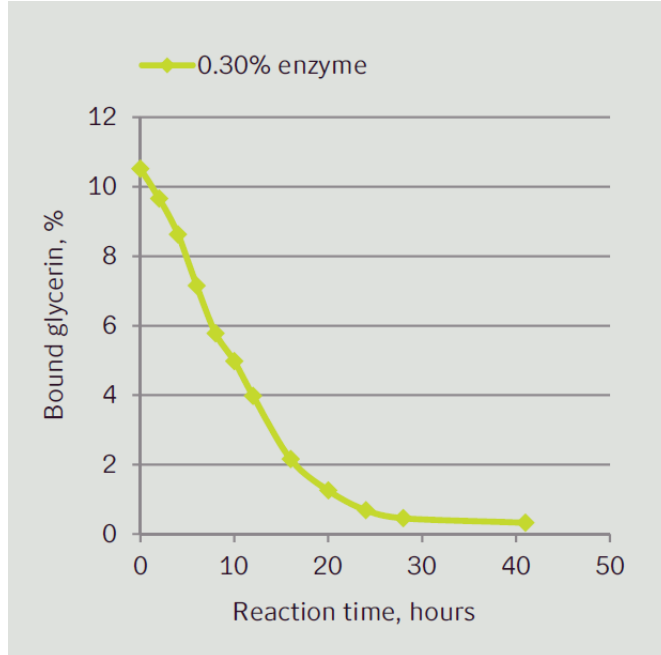
FAME →

Emulsion →

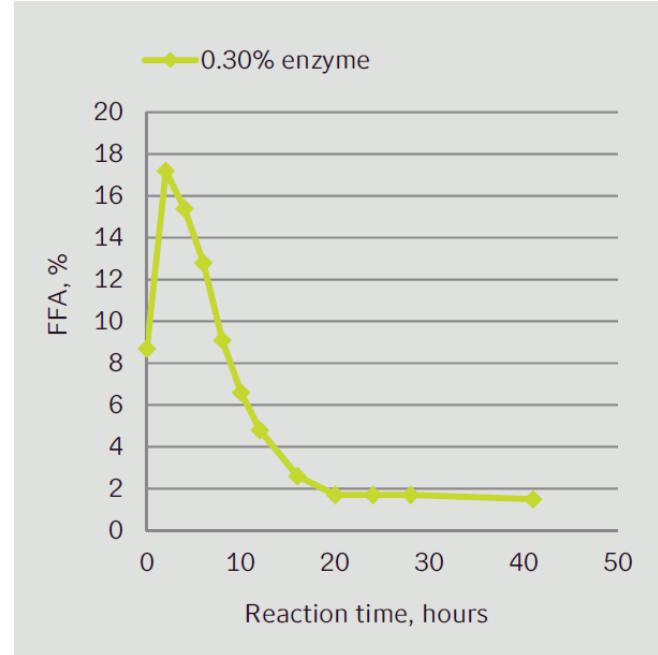
Glycerine →



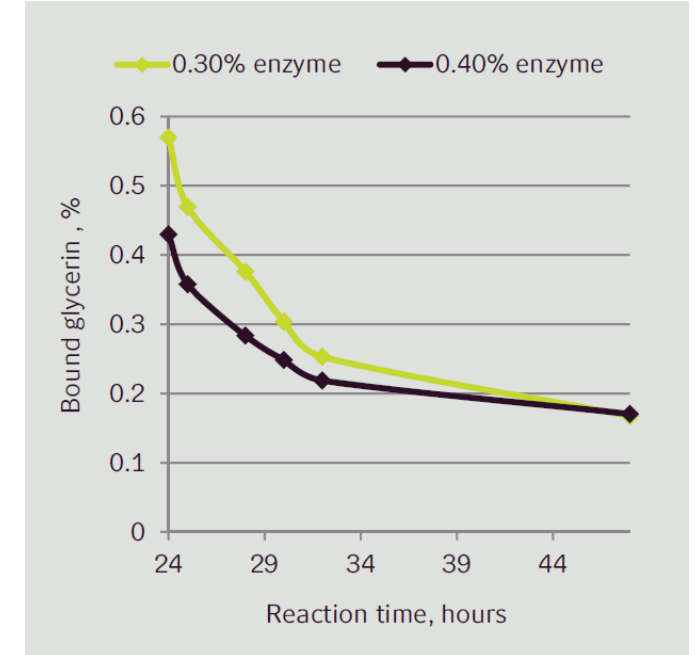
Example: UCO Enzymatic Reaction



Bound Glycerin reduced over the reaction period of 40 Hours

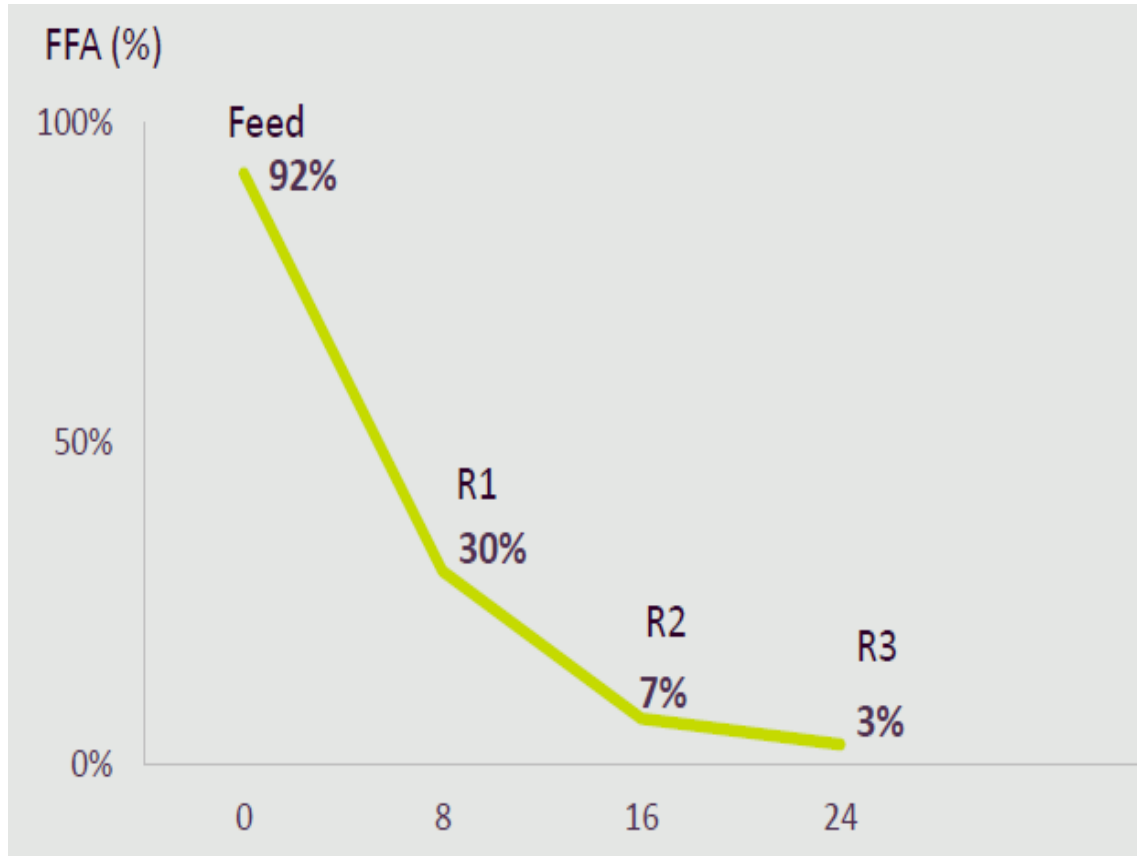


FFA increased at the beginning of reaction, after hydrolysis reaction of breaking down glyceride to FFA, then follow by esterification process.



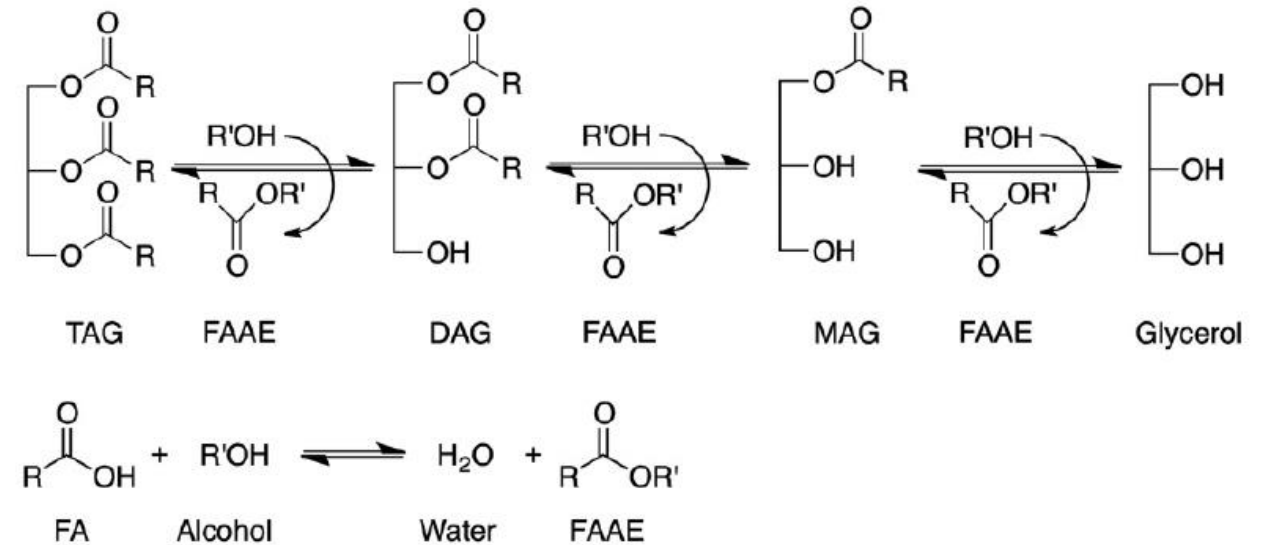
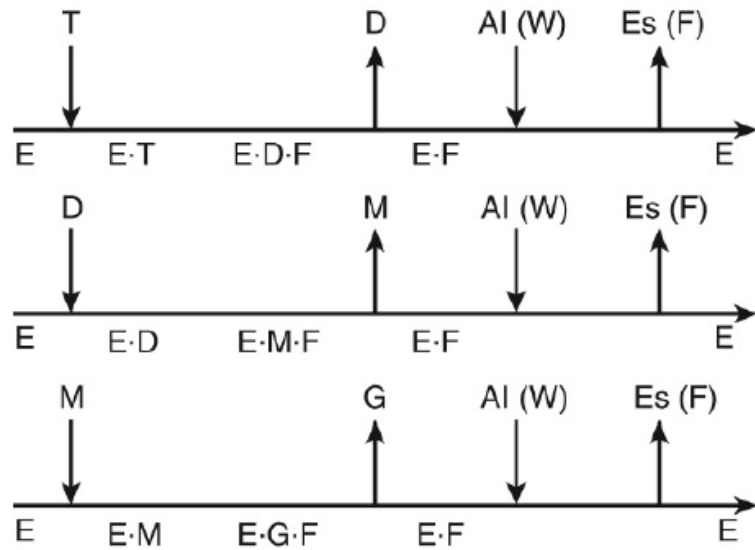
2 curve with different enzyme dosage to demonstrate higher enzyme dosage promote acceleration of reaction.

Example: PFAD Enzymatic Biodiesel



- PFAD is considered very high or pure FFA feedstock, therefore the reaction happens at a much higher rate.
- The graph is captured based on the CTSR model, where the 1st reactor (R1) is pre-filled with FAME, then followed by a continuous feed.
- Within 24 hours, the enzyme can convert most of the FFA into FAME, thus the FFA can achieve a lower than 3.0% after 24 hours of reaction.
- Based on plant experience, MG and TG will be on the lower side, DG will be around 0.20.
- The subsequent neutralization step will neutralize the remaining FFA and also bring down the DG via saponification.

Enzymatic Reaction Chemistry



Source: Diagram of **Ping-Pong Bi Bi Mechanism** for the stepwise Transesterification starting from TAG (T) ([Cheirslip et al., 2008](#))

Source: Overall reactions taking place during transesterification, where TAG, DAG, MAG, and FFA are converted into Fatty Acid Alkyl Esters ([Firdaus et al., 2008](#))

Example of enzymatic FAME from PFAD and Sludge oil

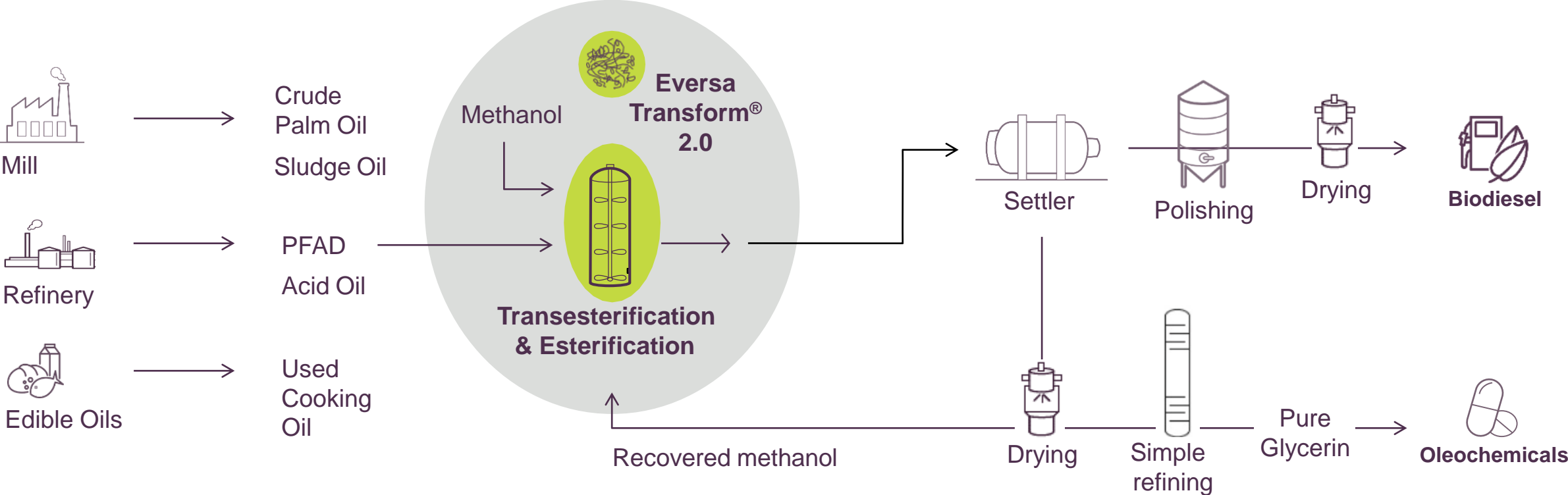


Quality Parameters: Enzyme process from PFAD Feedstock without distillation

Method	Unit	ASTMS 6571-D	EN14214	Enzyme Processed
Ester content	%		>96.5	97.1
Sulphur content	Mg/kg	0.05 (Grade S500)	<10.0	5.0
Cetane number	-	>47	>51.0	61.1
Oxidation stability 110 deg	Hours (accelerated)	>3.0	>8.0	28.8
Acid value	Mg KOH/g	<0.50	<0.50	0.39
Monoglyceride	%	<0.40	<0.70	0.56
Diglyceride	%		<0.20	0.15
Triglyceride	%		<0.20	0.17
Free glycerine	%	<0.02	<0.02	0.01
Total glycerine	%	<0.240 (Bound Glycerol)	<0.25	0.19

Distillation is required for sludge oil and UCO to remove high unsaponifiables and sulphur

No FFA level restriction on feedstock for enzymatic biodiesel production



Feedstock flexibility

Reduced harsh chemicals

Higher purity glycerin

Easy retrofit/new installation

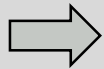
Conventional Biodiesel Technology Overview

Feedstock	Process 1	Process 2	Product
Crude Vegetable Oil 95% Tri-Gly + 4-5% FFA - Palm Oil - Coconut Oil	Refining (RBD) FFA Removal By-Product: FAD	Transesterification Tri-Gly to FAME Catalyst: SM30	Fatty Acid Methyl Esters (FAME) + Crude Glycerine
Fatty Acid Distillate (FAD) 85-90% FFA + 10-15% Tri-Gly	Direct Esterification FFA to FAME Catalyst: H ₂ SO ₄	Transesterification Tri-Gly to FAME Catalyst: SM30	Fatty Acid Methyl Esters (FAME) + Crude Glycerine
	Glycerolysis FFA + Gly to Tri-Gly	Transesterification Tri-Gly to FAME Catalyst: SM30	Fatty Acid Methyl Esters (FAME) + Crude Glycerine

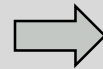
Additional step is required to process the feedstock before transesterification.....

Whereas biodiesel processing with enzymes removes the rigidity factors

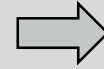
CPO
PFAD
Sludge Oil
Acid Oil
UCO



**Transesterification
+ Esterification**
Single step
Prewash if required



**Polishing
Step**



**BIODIESEL
(FAME)**

Rigidity Factors

Low FFA oils ✓
High FFA oils ✓
PFAD and sludges ✓

By direct esterification.....



Summary

- Recycling secondary oil to food chain will bring detrimental impact to human health
- Turning secondary or waste into Biodiesel is one of the best solution for environment and health protection
- Industry needs to find a balance to manage higher Biodiesel mandates and by-product generation from conventional processes
- Enzymes gives you the flexibility and freedom to run your Biodiesel process by choosing the most cost-effective feedstock



Choose a feedstock that works for you

Lower raw material costs. Increased safety. High-quality glycerin. With best-in-class enzymatic solutions, you can ensure your business flows along smoothly.



Let's transform the quality and sustainability of your business

Don't let profits go to waste

Rising raw material costs is prompting the biodiesel industry to look for alternatives that can minimize the dependence on conventional feedstock.

With best-in-class enzymatic solutions, you can now take control of your feedstock costs.

[Get in touch today](#)

Visit our website to view more info and video about enzyme technology

Questions

Thank you

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