Research and Testing at the edible oil extraction and refining factory of

By Inaya Fawad
Jumeirah College

Abstract Summary:
This research paper delves into the processes and testing conducted at Unity Foods' edible oil extraction and refining factory. The study highlights the extraction and refining of palm oil and soybean oil, detailing steps such as sterilization, pressing, degumming, neutralization, bleaching, and deodorization. The refining process ensures the removal of impurities and meets quality standards. The paper also discusses the chemical and physical testing results, including parameters such as Free Fatty Acid (FFA) percentage, discharge oil temperature, color measurement, moisture percentage, and soap PPM. These tests are crucial to ensure the quality and safety of the produced oils. Additionally, the paper briefly touches upon the production of biofuel from palm oil through transesterification, emphasizing the economic and environmental advantages of using palm oil as a feedstock

Acknowledgements

This research was done under the guidance of Zubair Ahmad – Head of Research and Development at Unity Foods. I would like to express my heartfelt gratitude to my research supervisor for his invaluable guidance and support throughout this research project. His extensive knowledge and expertise, particularly in the field of chemical engineering, have greatly contributed to my understanding of the subject matter.

With a remarkable 40 years of professional experience, Zubair Ahmad has worked with esteemed organizations such as Unilever Pakistan, Tetra Pak, and IFFCO UAE. His insights and encouragement have been instrumental in shaping the direction of my research and enhancing the quality of my work.

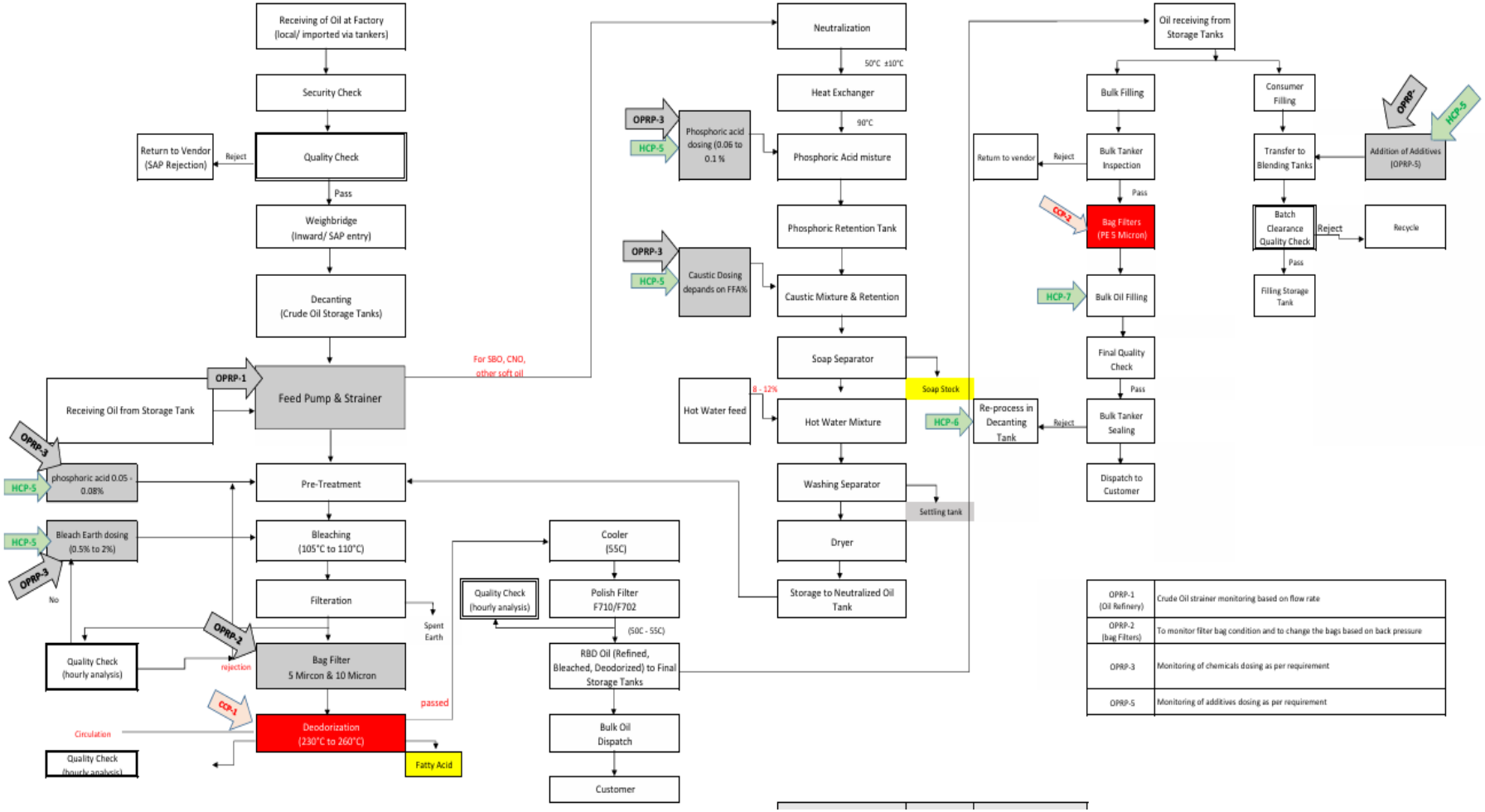
I am truly thankful for his mentorship, patience, and unwavering support, which have inspired me to strive for excellence in my research endeavors.

Unity Foods – Edible Oil Factory

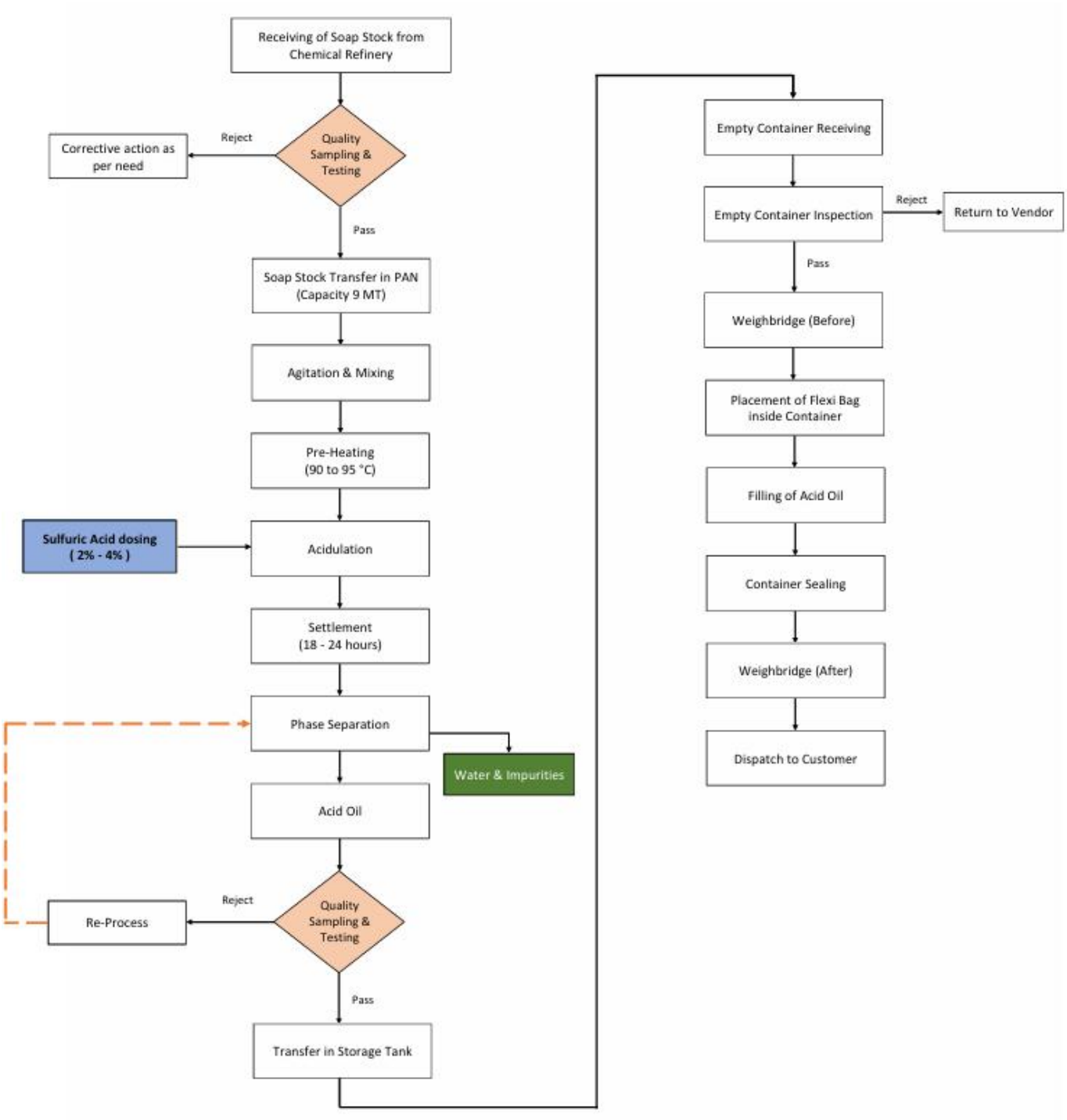
Unity Foods is primarily engaged in the extraction and refining of edible oils. Their factory focuses on producing high-quality palm oil and other vegetable oils. The process begins with import of the harvest of palm fruits, which are then transported to the factory. The fruits undergo sterilization to prevent the formation of free fatty acids and are then stripped of their outer layer. The stripped fruits are pressed to extract crude palm oil, which is then purified and refined to produce edible palm oil and other products.

The refining process involves several steps, including degumming, neutralization, bleaching, and deodorization. These steps remove impurities and ensure the oil meets quality standards. The factory also produces by-products such as palm kernel cake and empty fruit bunches, which can be used for animal feed, compost, or further processed into biogas.

Process flow of the Crude Palm Oil Refinery



Process flow – Acid Oil Refinery



Chemical and Physical Refinery Testing

Time	Chemical Refinery							Physical Refinery								FAD %	Discharge Oil Temp C	Remarks
	Dryer							Bleacher Oil			Deodorizer							
	Type of Oil	FFA %	Colour 1" Cell			Soap PPM	Moisture %	FFA %	Colour 5.25" Cell		FFA %	Colour 5.25" Cell		Peroxide Value meq/kg	Moisture %			
			Red	Yellow	Blue				Red	Yellow		Red	Yellow					
10:00	SBO	0.24	3.6	36	0	430	0.22	0.27	2.9	29	0.045	1	10	0	0	0	56C	OK
11:00	SBO	0.22	3.6	36	0	430	0.22	0.22	2.7	27	0.043	0.9	9	0	0	0	57C	OK
12:00	SBO	0.12	3.6	36	0	200	0.12	0.21	2.5	25	0.042	0.8	8	0	0	0	56C	OK
13:00	SBO	0.14	3.6	36	0	198	0.092	0.2	2.4	24	0.04	0.8	8	0	0	0	55C	OK
14:00	SBO	0.14	3.6	35	0	205	0.10	0.22	2.4	24	0.048	0.8	8	0	0	0	57C	OK
15:00	SBO	0.12	3.6	35	0	153	0.092	0.28	2.3	23	0.05	0.8	8	0	0	0	58C	OK
16:00	SBO	0.20	3.6	36	0	120	0.087	0.23	2.5	25	0.044	0.8	8	0	0	0	56C	OK
17:00	SBO	0.16	3.5	36	0	138	0.09	0.27	2.3	23	0.041	0.8	8	0	0	0	57C	OK
18:00	SBO	0.17	3.5	33	0	166	0.093	0.2	2.5	25	0.04	0.8	8	0	0	0	58C	OK
19:00	SBO	0.17	3.4	32	0	133	0.11	0.19	2.6	26	0.047	0.9	9	0	0	0	56C	OK
20:00	SBO	0.17	3.4	32	0	150	0.12	0.17	2.8	28	0.046	0.8	8	0	0	0	56C	OK

What is Biofuel

Biofuel is a type of renewable energy source derived from organic materials, such as plants, agricultural residues, and animal waste. It can be produced in various forms, including bioethanol, biodiesel, and biogas.

Unity Foods is also involved in the production of biofuel from palm oil. The process of transesterification is commonly used to convert palm oil into biodiesel, involving the reaction of the oil with an alcohol (usually methanol) in the presence of a catalyst to form biodiesel and glycerin. This contributes to renewable energy goals and supports local economies.

A palm oil refinery producing biofuel makes sense for several reasons, both economic and environmental:

1. **Raw Material Availability**: Palm oil is one of the most efficient oil crops, producing more oil per hectare than other vegetable oils. This makes it a cost-effective feedstock for biofuel production.
2. **Energy Production**: Biofuels derived from palm oil can be considered renewable as they come from a biologically grown crop, which can be replanted. When sustainably managed, palm oil biofuels can help reduce greenhouse gas emissions compared to fossil fuels.
3. **Utilization of By-products**: The refining process generates by-products such as palm kernel cake and empty fruit bunches, which can be used for animal feed, compost, or further processed into biogas, enhancing overall sustainability.
4. **Sustainability Initiatives**: Many palm oil producers are adopting sustainability certifications (like RSPO - Roundtable on Sustainable Palm Oil) to promote responsible cultivation and processing, addressing concerns about deforestation and biodiversity loss. Technological advancements in refining and processing can improve the efficiency of biofuel production and reduce environmental impacts.

Development of Biofuel

The development of biofuel involves several key steps, each contributing to the conversion of biomass into usable energy. Here's an overview of the typical process:

1. Feedstock Selection
Choosing the right feedstock is crucial. Common sources include:
- Crop Plants: Such as corn, sugarcane, and soybeans.
- Waste Materials: Agricultural residues, food waste, and animal manure.
- Algae: A rapidly growing source that can produce oils and biomass.

2. Biomass Collection
The selected feedstock is harvested and collected. This can involve:
- Cultiation: Growing specific energy crops.
- Collection: Gathering agricultural residues or waste materials.

3. Preprocessing
Before conversion, biomass often undergoes preprocessing to make it suitable for biofuel production:
- Size Reduction: Chopping or grinding the biomass to increase surface area.
- Drying: Reducing moisture content to improve efficiency in subsequent processes.

4. Conversion Processes
This is the core step where biomass is converted into biofuels. There are several methods, depending on the type of biofuel

Conclusion

The development of biofuels is a complex, multi-step process that transforms organic materials into renewable energy. Each stage is vital to ensure that the biofuel produced is efficient, sustainable, and environmentally friendly.

At Unity Foods, the principal business activity of the Company is edible oil extraction and refining. A palm oil refinery producing biofuel makes sense for several reasons, both economic and environmental:

1. Raw Material Availability
- High Yield: Palm oil is one of the most efficient oil crops, producing more oil per hectare than other vegetable oils. This makes it a cost-effective feedstock for biofuel production.

- Established Industry: Many countries, particularly in Southeast Asia, have established palm oil plantations and processing facilities, providing a steady supply of raw material.

2. Energy Production
- Renewable Energy Source: Biofuels derived from palm oil can be considered renewable as they come from a biologically grown crop, which can be replanted.

- Carbon Neutrality Potential: When sustainably managed, palm oil biofuels can help reduce greenhouse gas emissions compared to fossil fuels, as the plants absorb CO_2 during their growth.

3. Economic Benefits
- Job Creation: The production of biofuel from palm oil can create jobs in agriculture, processing, and distribution, benefiting local economies.

- Market Demand: With increasing global demand for renewable energy, palm oil biofuel can help meet energy needs while providing an additional revenue stream for palm oil producers.

4. Utilization of By-products
- Waste Management: The refining process generates by-products such as palm kernel cake and empty fruit bunches, which can be used for animal feed, compost, or further processed into biogas, enhancing overall sustainability.

5. Sustainability Initiatives
- Certification Schemes: Many palm oil producers are adopting sustainability certifications (like RSPO - Roundtable on Sustainable Palm Oil) to promote responsible cultivation and processing, addressing concerns about deforestation and biodiversity loss.

- Technological Advancements: Innovations in refining and processing can improve the efficiency of biofuel production and reduce environmental impacts.

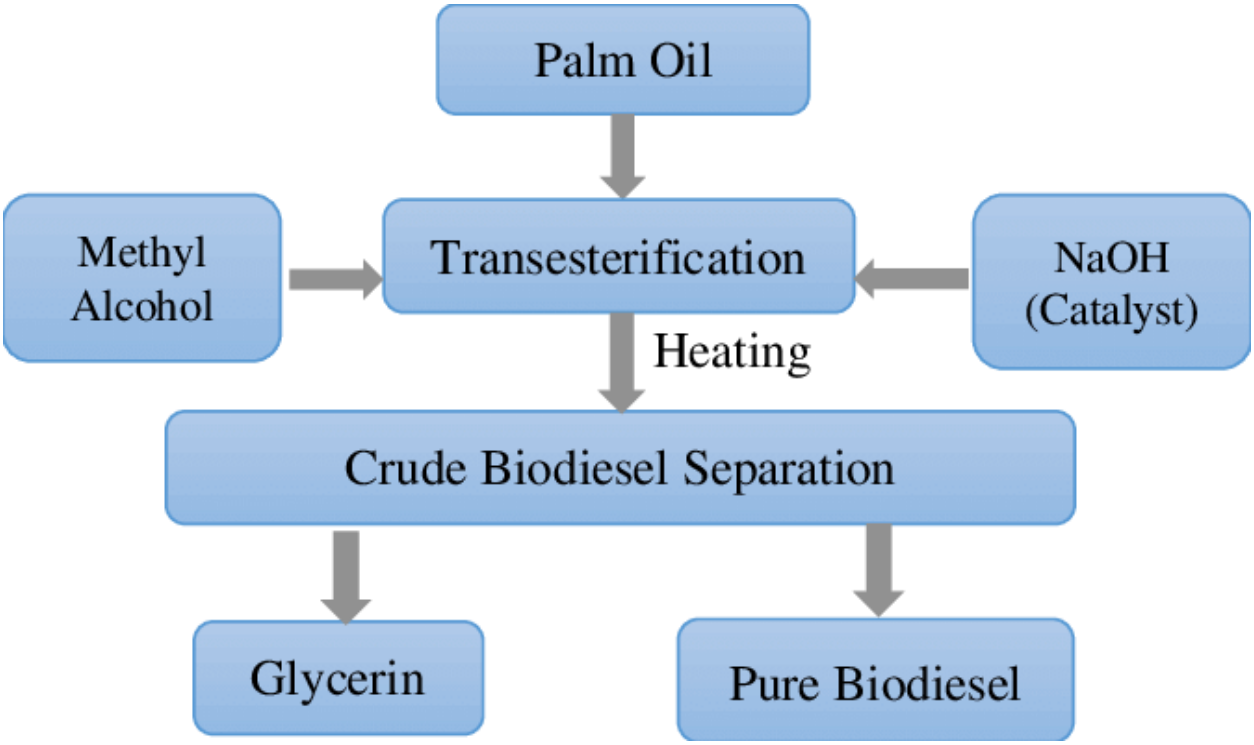
Conclusion – why it makes sense for Unity Foods
In summary, a palm oil refinery producing biofuel can leverage the high yield and economic potential of palm oil, contribute to renewable energy goals, and support local economies. However, it is crucial to ensure that palm oil production is managed sustainably to mitigate environmental concerns associated with deforestation and land use changes.

Process

Transesterification: This is the most common method for producing biodiesel. It involves reacting the feedstock with an alcohol (usually methanol) in the presence of a catalyst to form biodiesel and glycerin.

Pretreatment: Waste feedstocks often contain impurities that need to be removed before the transesterification process. This may include filtering, neutralizing, and drying.

Catalysts: Both homogeneous (liquid) and heterogeneous (solid) catalysts can be used. Bifunctional catalysts are being explored to improve efficiency, especially for feedstocks with high free fatty acid content.



Technical demographic

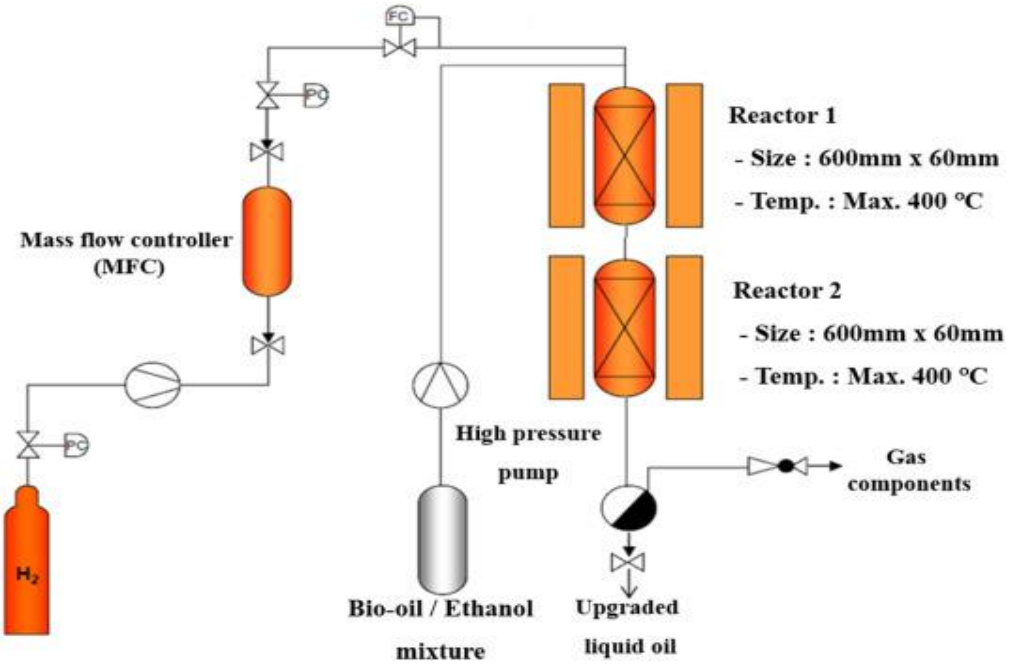
Transesterification is the process of **exchanging the organic functional group R" of an ester with the organic group R' of an alcohol**. These reactions are often catalyzed by the addition of an acid or base catalyst.

Esters are produced when carboxylic acids are heated with alcohol in the presence of an acid catalyst. The catalyst is usually 'concentrated Sulphuric acid'.

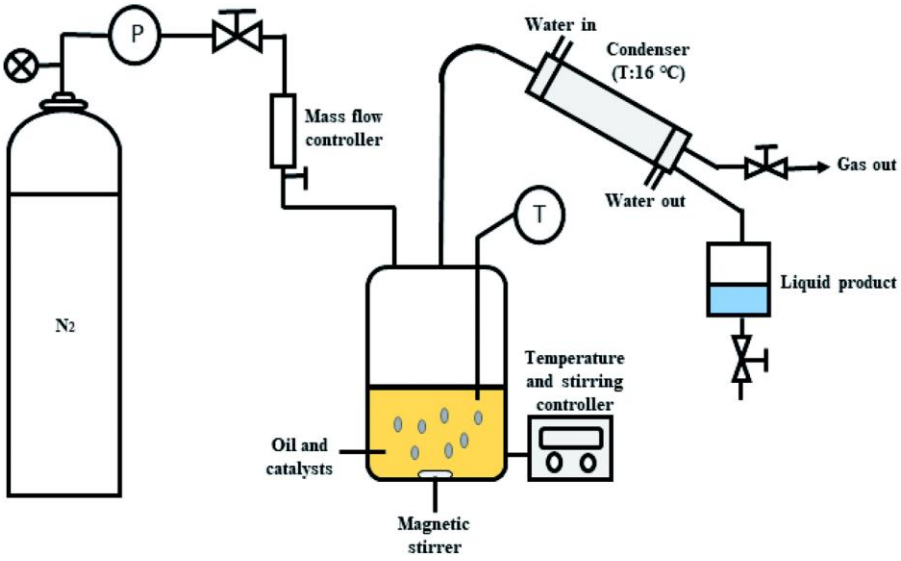
Difference between Alcohols and Esters.
Alcohol can combine with many kinds of acids to form esters. When no type of acid is specified, the word ester is assumed to mean a carboxylic ester, the ester of an alcohol and a carboxylic acid.

Fatty acid methyl esters (FAME) are **a type of fatty acid ester that are derived by transesterification of fats with methanol**. The molecules in biodiesel are primarily FAME, usually obtained from vegetable oils by transesterification. They are used to produce detergents and biodiesel.

Hydrodeoxygenation (HDO) is a hydrogenolysis process for removing oxygen from oxygen-containing compounds. Typical HDO catalysts commonly are sulphided nickel-molybdenum or cobalt-molybdenum on gamma alumina.



Deoxygenation is a chemical reaction involving the removal of oxygen atoms from a molecule. The term also refers to the removal of molecular oxygen (O_2) from gases and solvents, a step technique and gas purifiers.



Potassium hydroxide as a catalyst in biodiesel Good biodiesel uses KOH as its caustic catalyst. **It produces high-quality fuel and is easy to mix with methanol**, plus its by-product can be used to make quality liquid soap or fertilizer.

Sodium Hydroxide NaOH (sodium hydroxide), CH3OH (methanol) and as base catalyst are mostly used in this process **because of their lowest costs, higher reaction rates and higher yields**. From the WCO generation of about 80 lites per week, yield for biodiesel production is considered in the range of 80-90%.

The methoxide ion, $^{-}OCH_3$, is the **active catalyst for the production of methyl esters**. It is this chemical unit that attacks triglyceride molecules and produces the methyl esters. It is regenerated at the end of each reaction step when a hydrogen ion is stripped from a nearby methanol molecule.

Advantages of Methoxide Catalysts in Biodiesel Production

The methoxide ion, $^{-}OCH_3$, is the active catalyst for the production of methyl esters. It is this chemical unit that attacks triglyceride molecules and produces the methyl esters. It is regenerated at the end of each reaction step when a hydrogen ion is stripped from a nearby methanol molecule.

The production of biofuel from palm oil at Unity Foods is a significant advancement in renewable energy, contributing to sustainable energy goals and supporting local economies. The transesterification process, which converts palm oil into biodiesel, is economically viable and environmentally beneficial. However, sustainable management of palm oil production is crucial to mitigate environmental concerns associated with deforestation and land use changes. Unity Foods' commitment to responsible cultivation and processing practices aligns with global renewable energy initiatives and demonstrates a proactive approach to sustainability, making a commendable step towards a sustainable energy future.