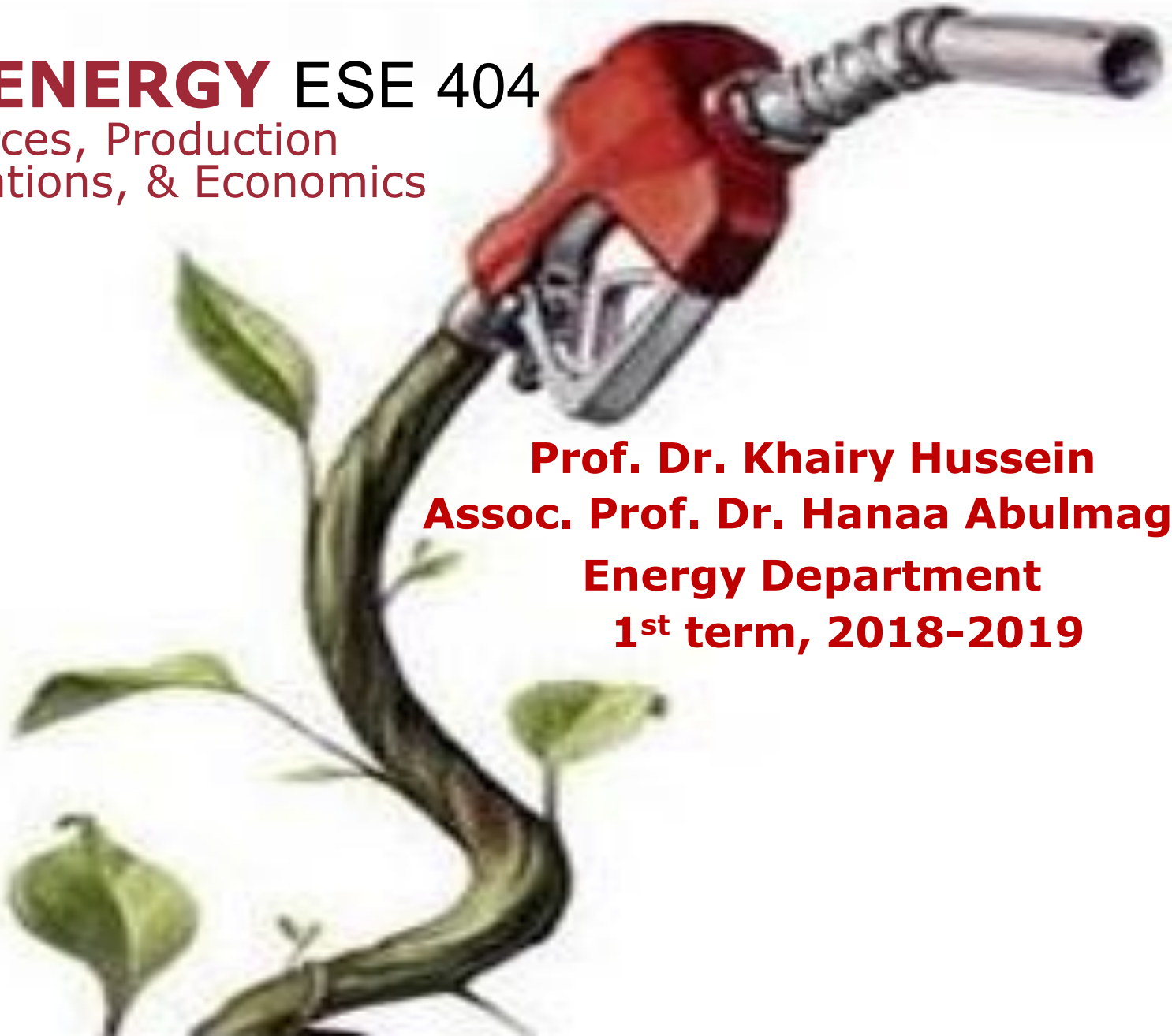


BIOENERGY ESE 404

Resources, Production
Applications, & Economics

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Energy Department
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Types of Biofuels

I) Liquid biofuel

- Biodiesel
- Bioalcohol
- ✓ Methanol
- ✓ Ethanol
- ✓ - butanol

II) Gas biofuel

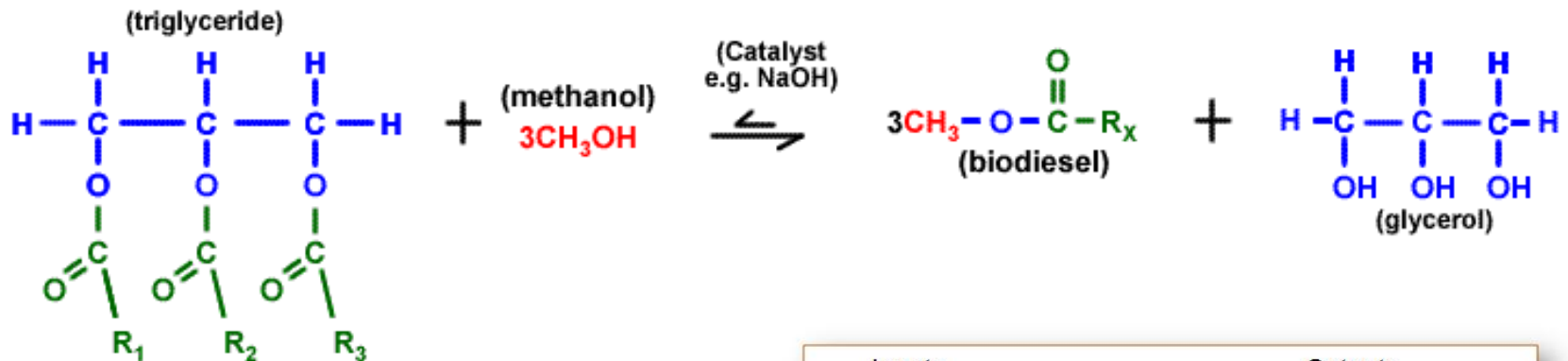
- Biogas
- Syngas

Liquid Biofuels

Types of Biofuels

1) Biodiesel

- It is a famous biofuel in Europe. It contains a reduced amount of carbon and higher hydrogen and oxygen content than fossil diesel.
- Synthesis:** Produced from trans-esterification of oils or fats mixing with methanol and sodium hydroxide.



Applications:

- 1- car diesel engine
- 2- effective solvent
- 3- oxygenated fuel



Trans-esterification

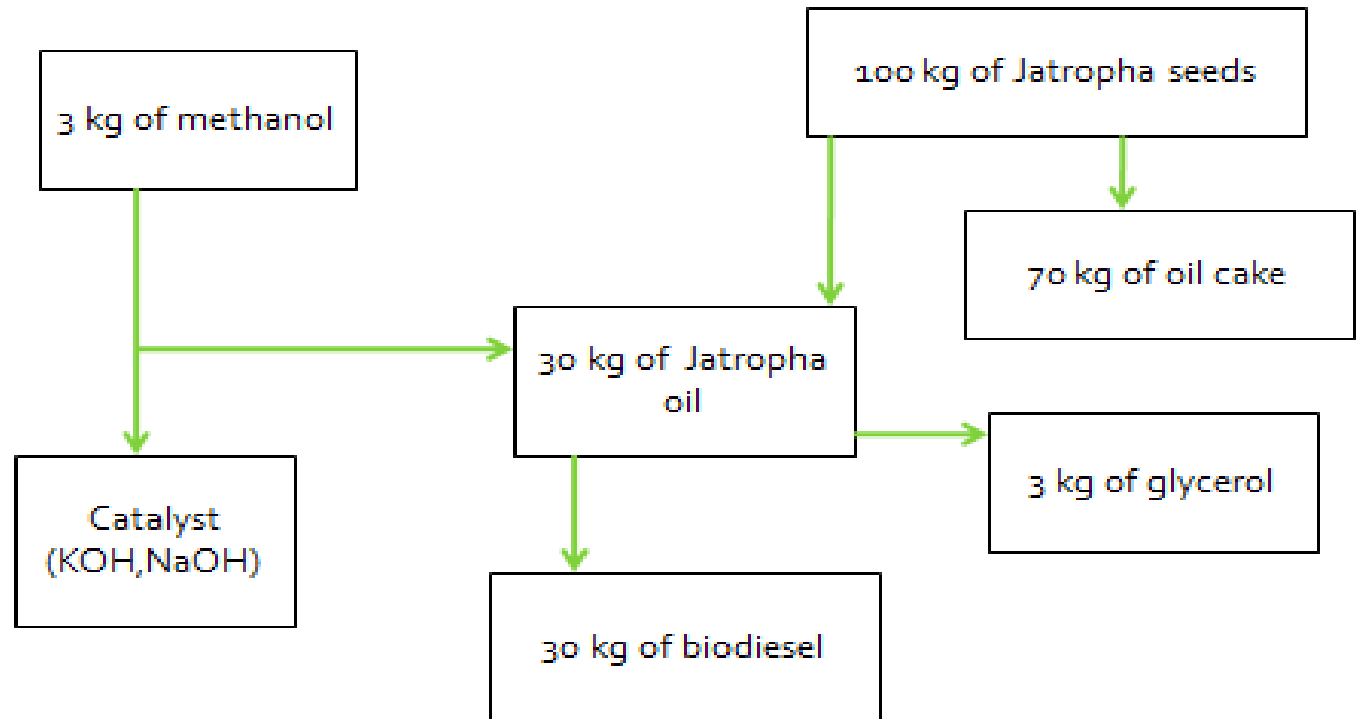
❖ It is base catalyzed reaction of oil with alcohol to form fatty acids and then to form alkyl esters (biodiesel).

❖ The formed biodiesel can replace the petroleum or mix with it.

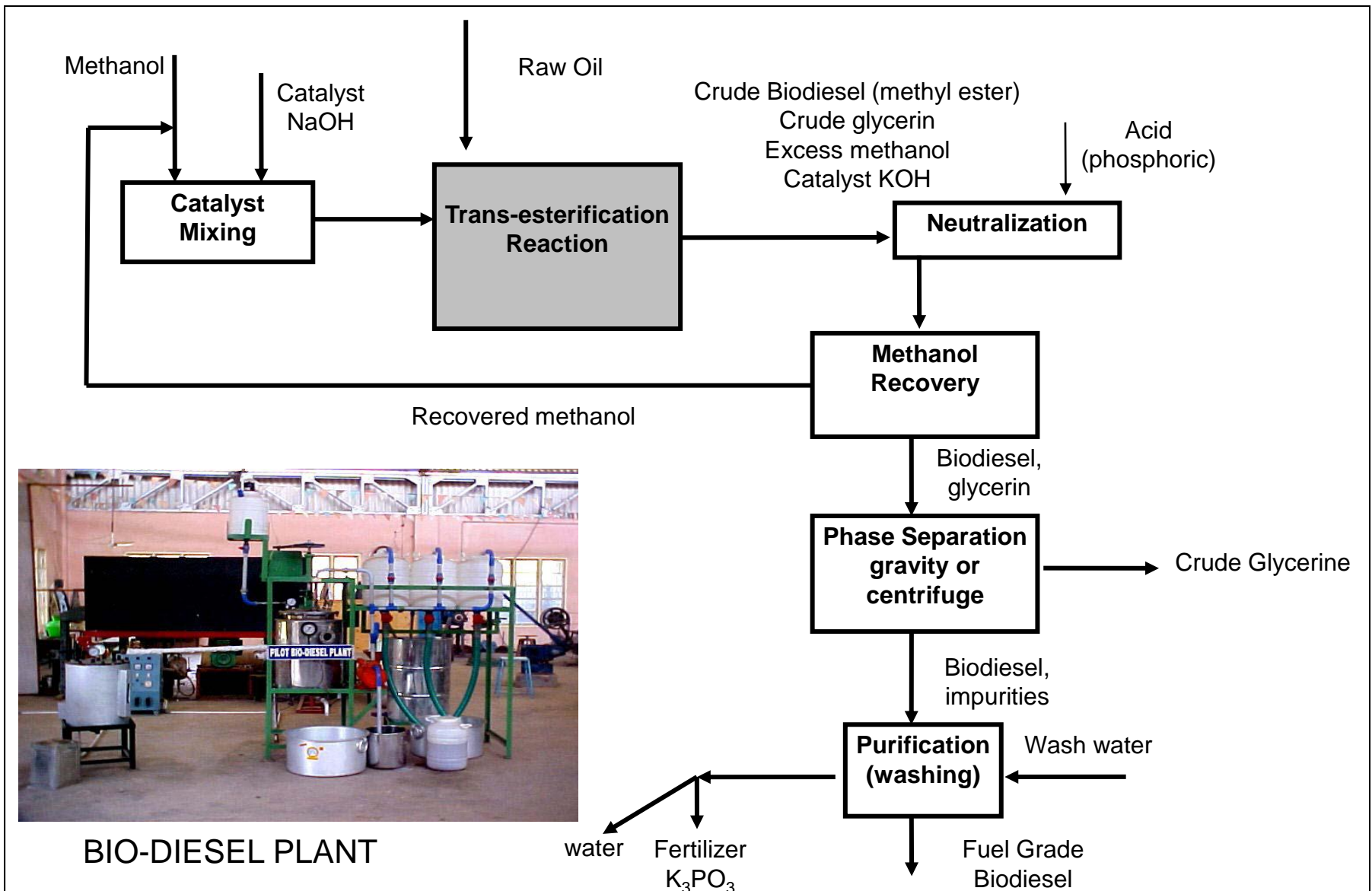
❖ Oils used in synthesis are: vegetable oil, animal fat, or grease.



Ex. Synthesis of biodiesel from Jatropha seeds



General Biodiesel Production scheme



Feedstock choices

The main feedstock for biodiesel fuel are:

1. Virgin oil feedstock:

Rapeseed - soybean - jatropha - mustard, flax, sunflower, palm oil, coconut



Soy bean



Rapeseed



Palm oil



Jatropha Curcas

2. Algae:

Algae can be grown using waste materials such as sewage and without making use of land used for food production.



3. Animal fats:

Yellow grease, chicken fat, and the by-products of the production of Omega-3 fatty acids from fish oil are increasingly used as biodiesel fuel feedstocks.



Advantages & Disadvantages of biodiesel



Advantages:

1. Clean fuel as it does not contain carcinogens, has lower sulphur content than the mineral diesel.
2. Biodiesel reduces carbon dioxide exhaust emissions by up to 80%.
1. The smell of the biodiesel exhaust is far more pleasant.
3. It possesses high lubricating property so engines last longer.
4. Improves engine efficiency and operating life cycle.
5. Readily mixes with petroleum diesel fuel in any ratio.
6. Has higher flash point, so it is safer in transport and storage.

Disadvantages:

1. Higher production cost.
2. Biodiesel attracts moisture more likely than petroleum diesel.

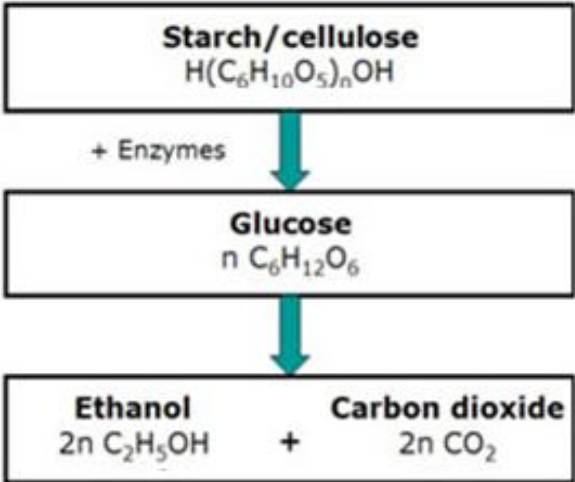
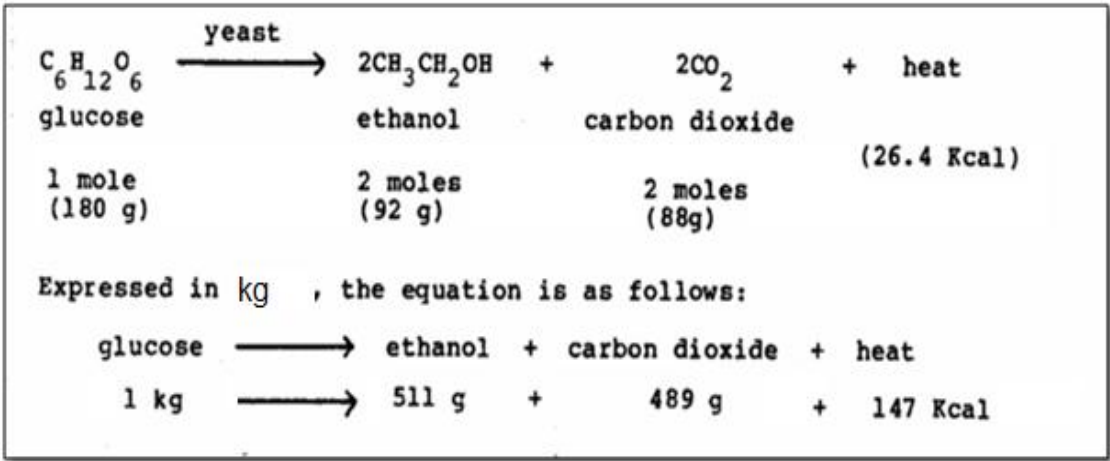
Liquid Biofuels

Types of Biofuels 2) Bioalcohols



- Biologically produced alcohols, most commonly ethanol, and less commonly propanol and butanol.
- Synthesis:** They are produced by the action of micro-organisms and enzymes through the fermentation of sugars or starches (easiest), or cellulose (which is more difficult because it requires pretreatment and burning of lignin).

Fermentation: a form of anaerobic respiration used primarily by yeasts when oxygen is not present in sufficient quantity.

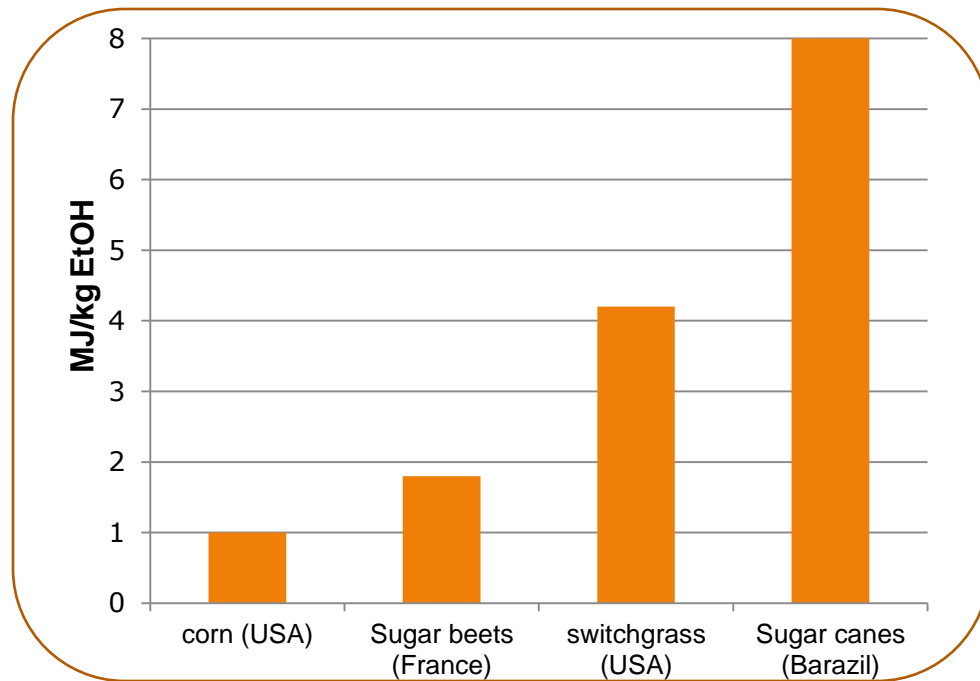


❑ Different feedstock:

Corn – sugar beets - sugar canes – switch grass

❑ Benefits of bio-alcohols

1. Renewable energy source.
2. Burns more cleanly because of its complete combustion.
3. Reduces greenhouse gases.
4. Fuel spills are more easily biodegraded or diluted to non-toxic materials.
5. Any plant can be used as feedstock provided that it contains sugar and starch.



❑ **Applications:** Bio-ethanol is the most commonly used bio-fuel in the world and particularly in Brazil. It is used as:

- 1- Petrol engines as a replacement for gasoline
- 2- Fuel for vehicles

Comparison of different liquid biofuels

Biofuels are counterparts to traditional fossil fuels, see table

- The energy content of biodiesel is about 90% that of petroleum diesel.
- The energy content of ethanol is about 50% that of gasoline.
- The energy content of butanol is about 80% that of gasoline.
- Biodiesel is sulfur free and it has fewer polycyclic aromatic hydrocarbons which cause cancer.

Biofuel	Fossil Fuel
Ethanol	Gasoline/Ethane
Biodiesel	Diesel
Methanol	Methane
Biobutanol	Gasoline/Butane

Lab work for biofuel synthesis

Synthesis of biodiesel from cooking oil waste



100 mL oil
87 g



0.8 g NaOH in 10 mL ethanol (0.5% catalyst & 10% alcohol of the oil mass)



Heating the oil at 130 °C



Adding the catalyzed alcohol to oil and keep stirring for 2 hours at 130 °C



After stirring, keep it for 12 hours till cooling and the glycerol settle down



Separating the oil (upper layer) from the glycerol (lower layer)



Adding some water to wash the oil from any residue, keep it two hours for separation

Lab work for biofuel synthesis

Synthesis of biodiesel from cooking oil waste



Separate the oil (upper layer) from the glycerol (lower layer)



Repeat the washing two more times or until the pH of the oil become 7 (neutral)



Now, you have biodiesel, keep it for testing



The glycerol part is ready for forming soap



Add some water and stir, soap foam is formed

Lab work for biofuel synthesis

Synthesis of bioethanol from sugar and yeast



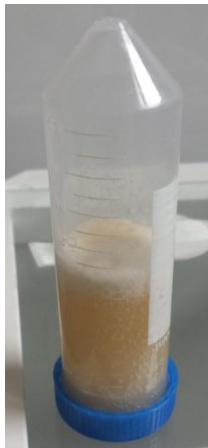
3 g sugar & 0.5 g yeast



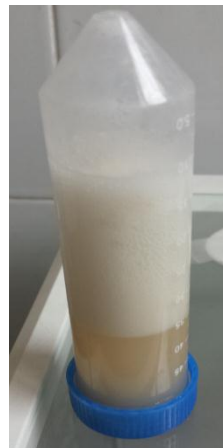
Making sugar solution, and dissolving the yeast in some water



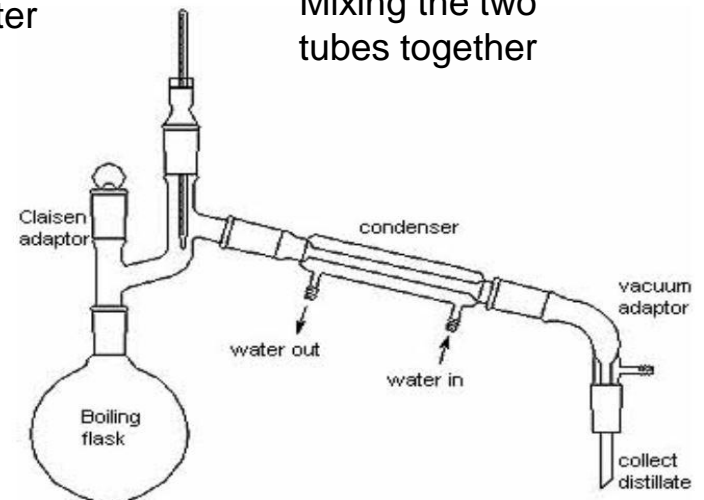
Mixing the two tubes together



Keeping for few hours



Ethanol is formed and should be distilled from the mixture



System used for distillation