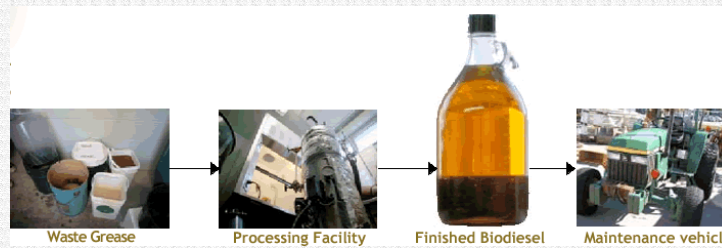


Biodiesel Project at UBC

Naoko Ellis
Chemical and Biological Engineering
UBC



Biodiesel

- An alternative diesel fuel made from renewable biological sources such as vegetable oils and animal fats



- “bio” represents the renewable and biological source in contrast to petroleum-based diesel fuel
- “diesel” refers to its use in diesel engines

Utilization of Vegetable Oil

- Direct use and blending
 - Coking and Carbon deposits
 - Plugging and gumming of filters
 - Engine wear
- Microemulsions
 - Carbon deposits
 - Injector needle sticking
- Thermal cracking
 - Removal of oxygen
 - Expensive equipment
- Transesterification
 - Effectively lowers the viscosity

Benefits of Biodiesel

- Significantly lower air pollutant emissions
- Can be blended with conventional diesel
- Enhanced lubricity for engines
- Allows for the recycling of waste vegetable oils
- More biodegradable and less toxic than conventional diesel
- Sustainable and renewable fuel

Biodiesel Emission

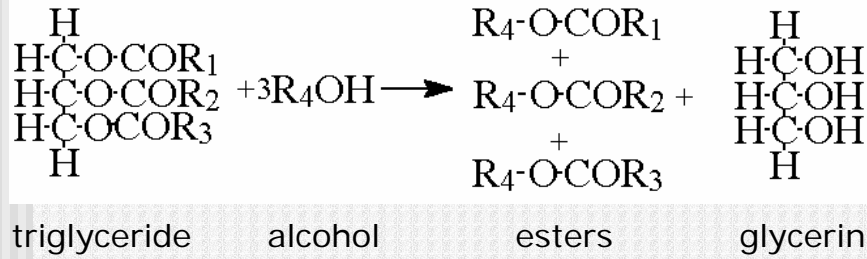
Emission	B100	B20
CO	-43.2%	-12.6%
HCs	-56.3%	-11.0%
NO _x	+5.8%	+1.2%
CO ₂	-78.3%	-15.7%
Particulates	-55.4%	-18.0%
Air Toxics	-60 to -90%	-12 to -20%
Mutagenicity	-80 to -90%	-20%

Source: http://www.eere.energy.gov/biomass/pdfs/biodiesel_handling.pdf

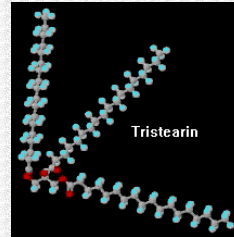
Sociological Impact

- Local community connection
- Reconnect with cyclic nature of ecosystems
- Waste recycling system
- Reduce dependency on foreign fuels
- Raise awareness of renewable energy sources
- Promote agriculture

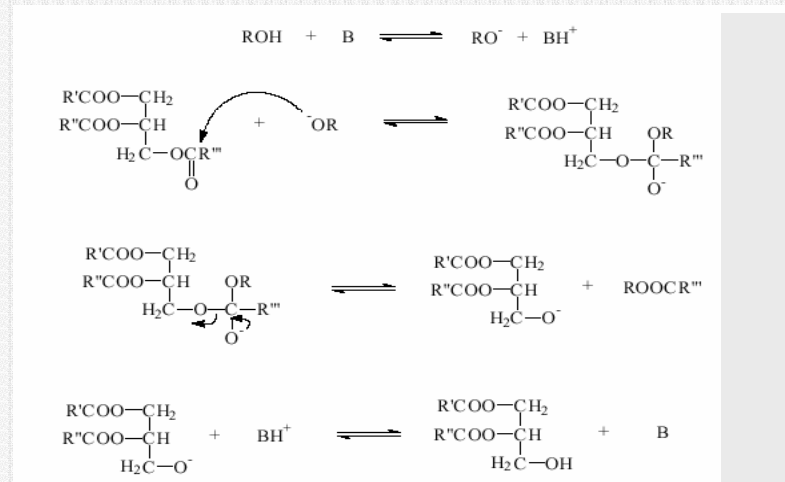
Transesterification Reaction Chemistry



- Stepwise reaction
- Removing the backbone of glycerin



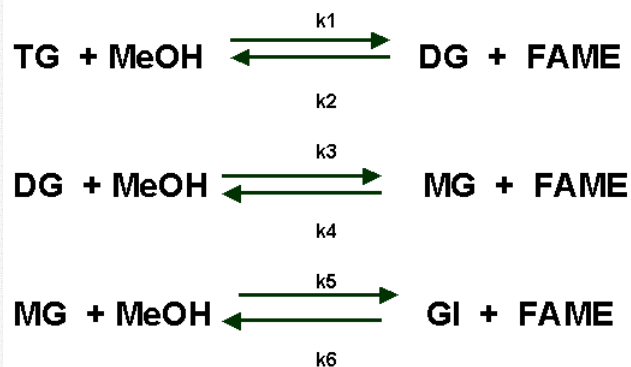
Mechanism



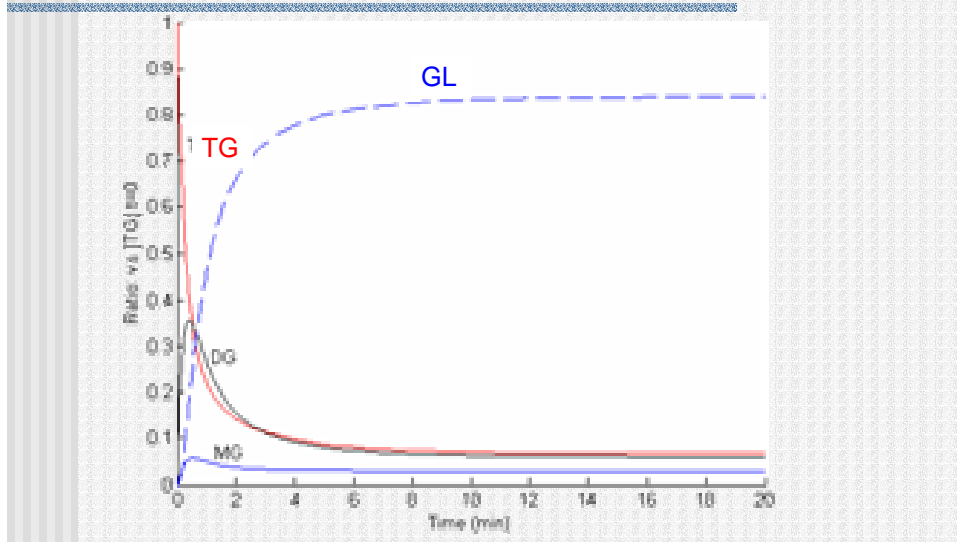
Main factors affecting conversion rate

- Molar ratio of glycerides to alcohol
- Catalyst
- Reaction temperature and time
- Contents of free fatty acids and water

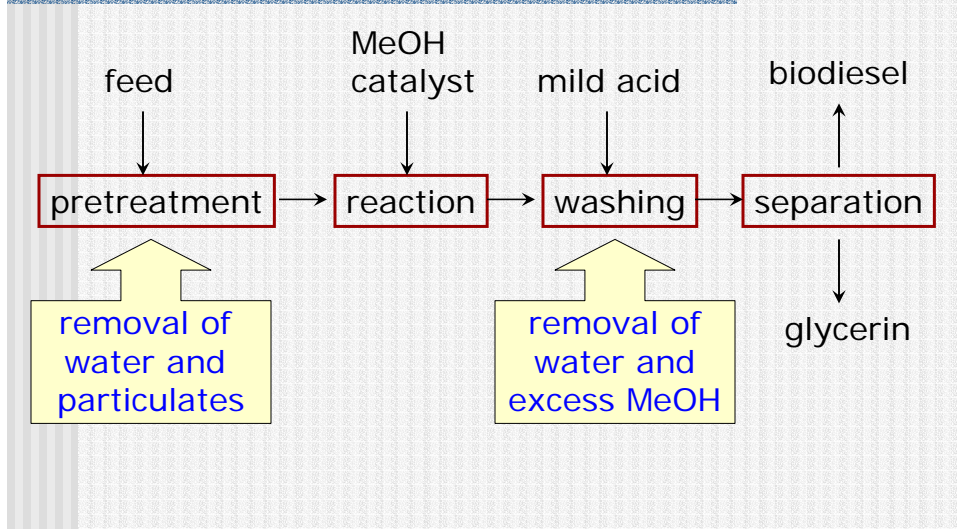
Stepwise Reactions



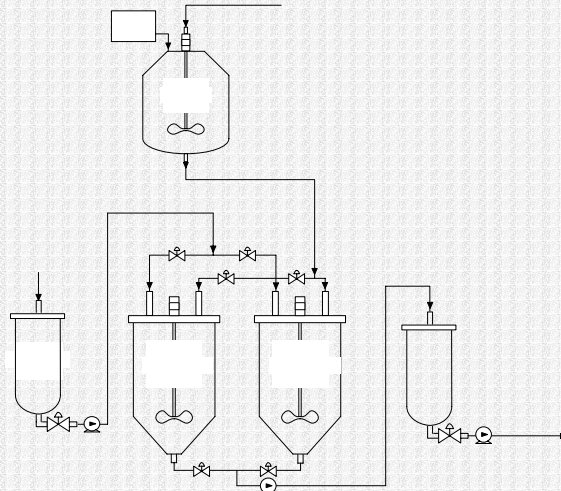
Simulated Concentration Profile



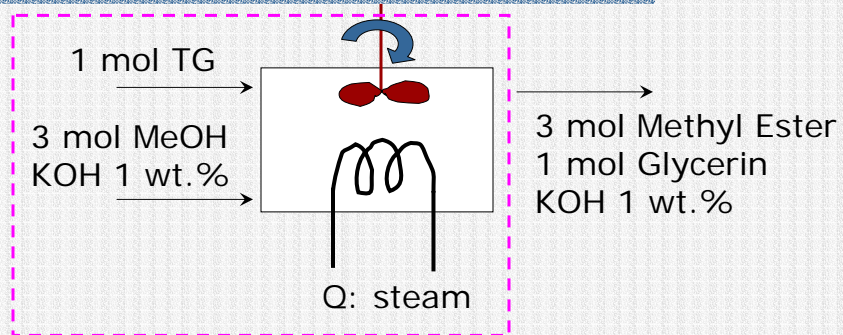
Process Description



Current Reaction Process Flow Diagram



Batch Process

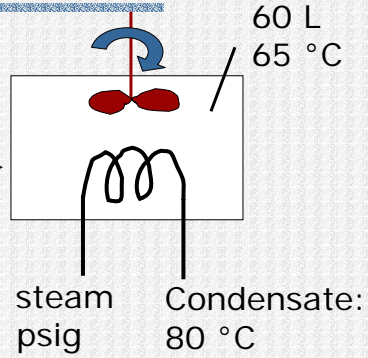


Initial Charge:
Reactants to be heated from 20 °C to 65 °C

Example:



Molar ratio
1 mol TG
3 mol MeOH
→
20 °C



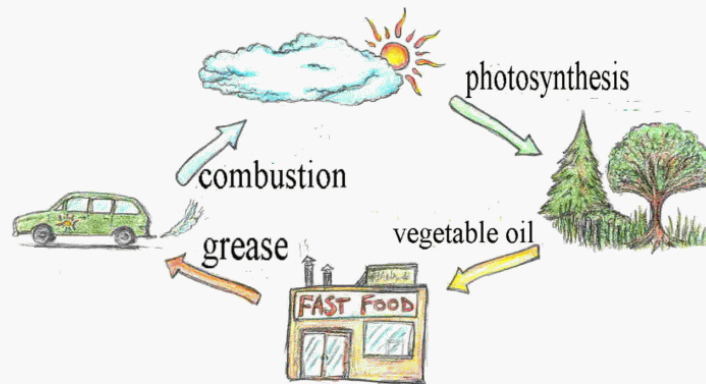
Typical Soybean Oil Methyl Ester Profile

Fatty Acid	Weight Percent	Mol. Wt.	Formula
Palmitic	12.0	270.46	$C_{15}H_{31}CO_2CH_3$
Stearic	5.0	298.52	$C_{17}H_{35}CO_2CH_3$
Oleic	25.0	296.50	$C_{17}H_{33}CO_2CH_3$
Linoleic	52.0	294.48	$CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7CO_2CH_3$
Linolenic	6.0	292.46	$CH_3(CH_2CH=CH)_3(CH_2)_7CO_2CH_3$

Source: www.biodiesel.org/pdf_files/Weight&Formula.PDF

Sustainability - Carbon Life Cycle

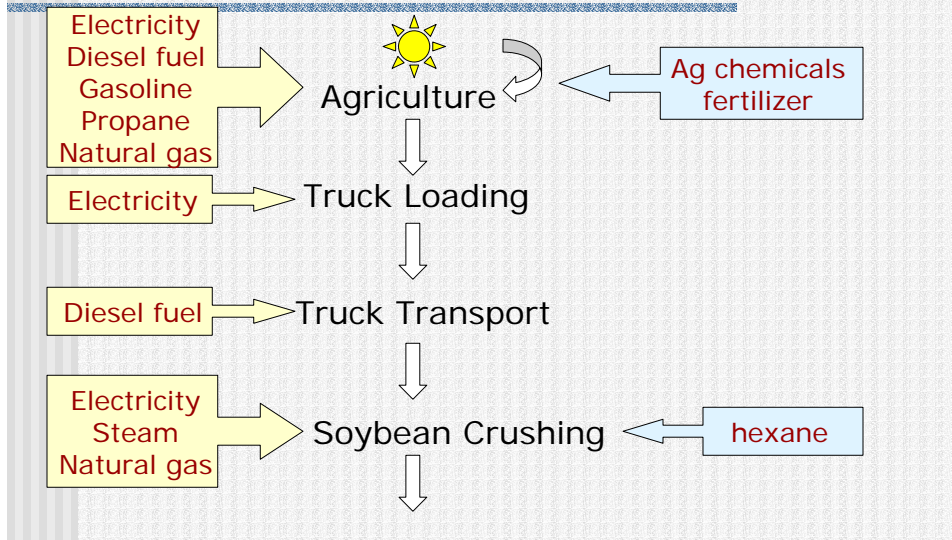
Zero Net Carbon Dioxide Emissions



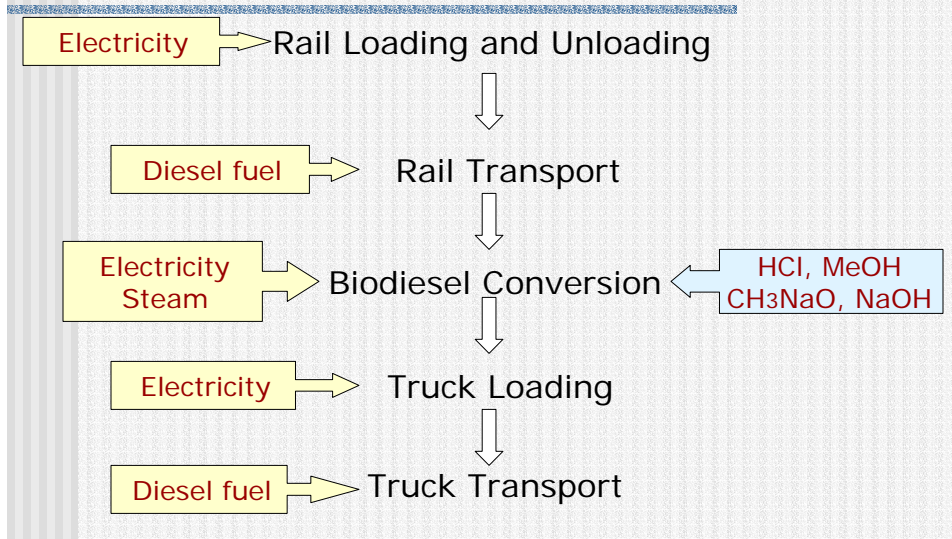
Life Cycle Inventory

- Provides an inventory of environmental and energy flows to and from the environment.
- Examines global issues, such as CO₂ emissions.
- “Input efficiencies for fossil energy sources”

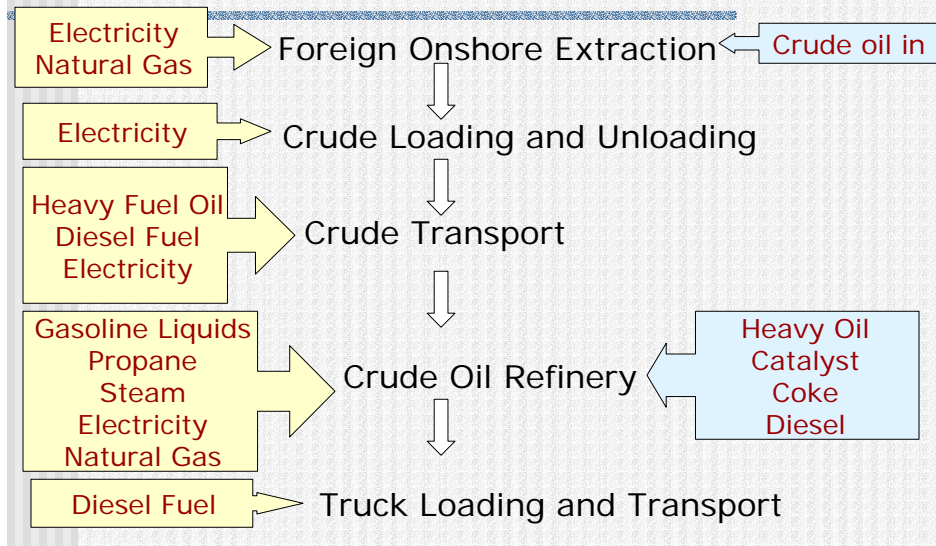
Energy Balance – Biodiesel (1)



Energy Balance – Biodiesel (2)



Energy Balance – Petroleum Diesel



Energy Life Cycle Inventory

Fuel	Energy Yield	Net Energy
Gasoline	0.74	- 26%
Diesel	0.83	- 17%
Ethanol	1.34	+ 34%
Biodiesel	3.20	+ 220%

- Biodiesel yields 3.2 units of fuel product energy for every unit of fossil energy consumed in its life cycle.
- Biodiesel reduces net CO₂ emissions by 78.5% compared to petroleum diesel.

Source: www.mda.state.mn.us/ethanol/balance.html

History of Biodiesel Project at UBC

- Biodiesel production at UBC started by two students, Geoff and Peter
- SFU lent the 60L batch Biodiesel reactor
- Naoko Ellis started academic research
- Environmental Youth Alliance initiated community linkages
- Campus Sustainability Office



UBC Biodiesel Pathway



Pilot Plant Design and Construction



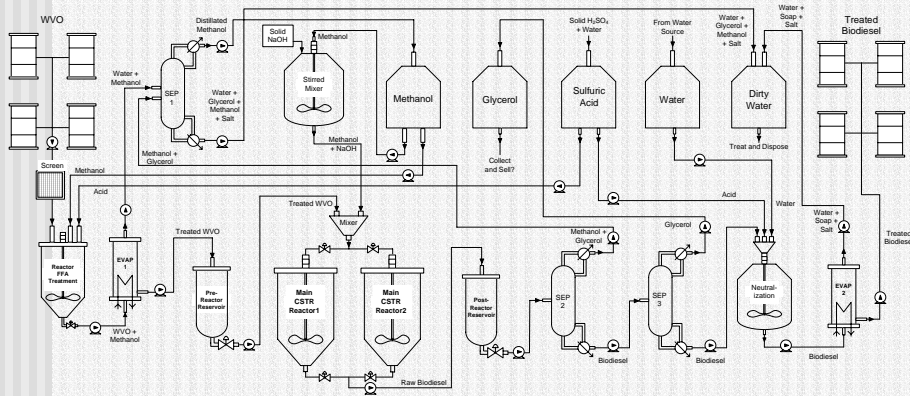
- 1000 L/day semi-continuous process
- Automatic control system



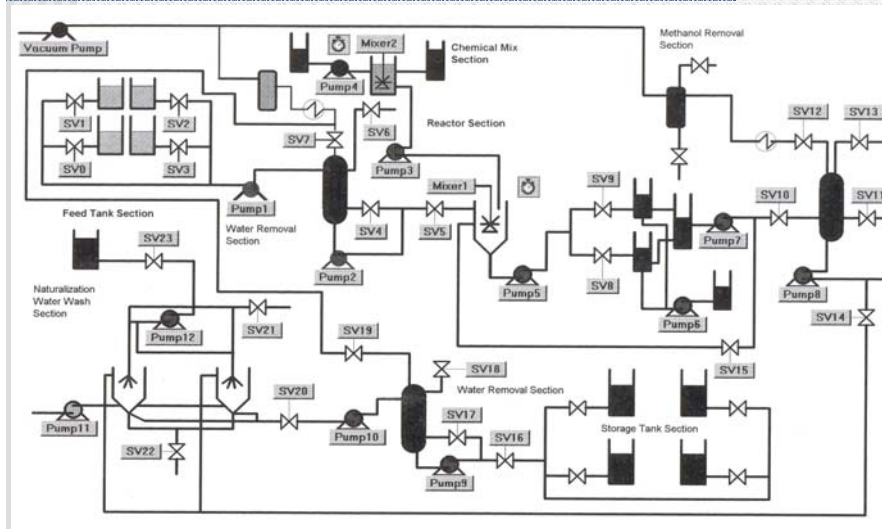
- Proof of concept on community scale model
- Feasibility study for small communities



Overall Process Flow Diagram



Process Control



Mobile Biodiesel Production Plant



Project Goals

- Provide community recycling plant and an environmentally clean energy source
- Provide skills training and education for young professionals
- Provide ongoing academic research into alternative clean fuels

Finally, grease that's good for you!



A new project by environmentally aware students may change the way we fuel our cars, save us from the collapse of the oil industry, and clean up the air. All the while, ensuring good quality french fries.



Source: www.peak.sfu.ca/the-peak/2002-3/issue3/fe-biodiesel.html
http://www.alumni.ubc.ca/files/pdf/trek/issues/04fall/10_French_Fries_Future.pdf

Further Information

- My website:

www.faculty.chml.ubc.ca/nellis/teaching

- Environmental Youth Alliance:

www.eya.ca/biodiesel

- Biodiesel

www.biodiesel.org