Application of Ultrasonics in Biodiesel Production Process

Priyanka Chand

Graduate Research Assistant

PhD Student

IOWA STATE UNIVERSITY

Department of Agricultural & Biosystems Engineering

Biomass Processing Laboratory

Presentation Outline

- Introduction
- Objectives
- Experimental
- Results
- Conclusions

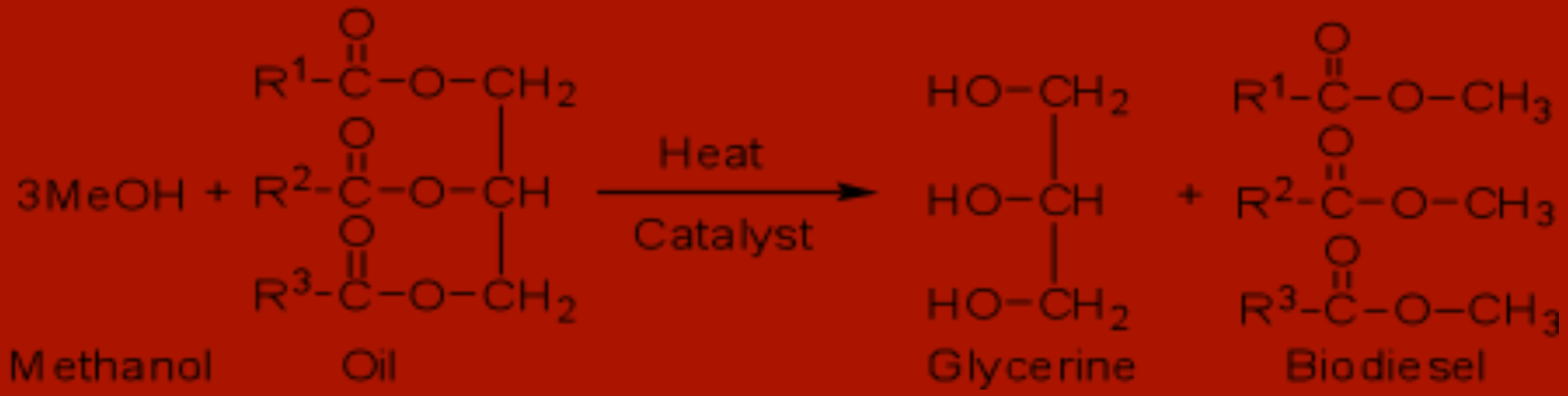
Biodiesel

Fuel property	No. 2 Diesel	Biodiesel (B100)
Density (gm/cu.cm.)	0.850	0.880
Net heating value (MJ/L)	36.09	32.97
Kinematic viscosity @ 40 °C	1.3-4.1	4.0-6.0
Specific gravity kg/l @ 60 °F	0.85	0.88
Flash point, °C	60 to 80	100 to 170
Water and sediment, vol. %	0.05 max	0.05 max
Carbon, wt. %	87	77
Hydrogen, wt. %	13	12
Oxygen, by dif. wt. %	0	11
Sulfur, wt. %	0.05 max	0.0 to 0.0024
Boiling point, °C	180 to 340	315 to 350

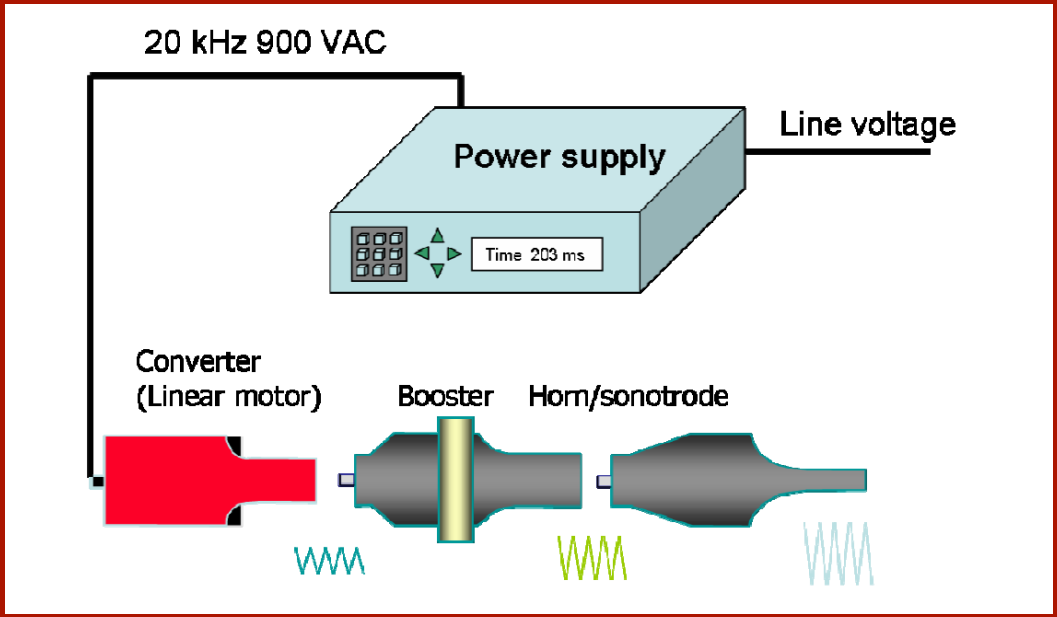
- **Biodiesel is the commercial name for fatty acid alkyl esters produced from triglycerides present in vegetable oil, animal fats, etc.**
- **It is a biorenewable source of energy.**
- **It can be used in diesel engines as such or can be blended with diesel.**

IOWA STATE UNIVERSITY
Department of Agricultural & Biosystems Engineering
Biomass Processing Laboratory

Transesterification Reaction



Ultrasonic Tooling Design



- Ultrasound waves have frequency above human hearing range i.e. >18 KHz
- When applied to liquid medium, ultrasound waves produce physical effects in the liquid such as cavitation and acoustic streaming

Objectives

- **Increase rate of reaction of transesterification from vegetable oil and thus decrease reaction time**
- **Extract oil from single-celled oleaginous microorganisms such as yeast and convert into biodiesel**

Experimental

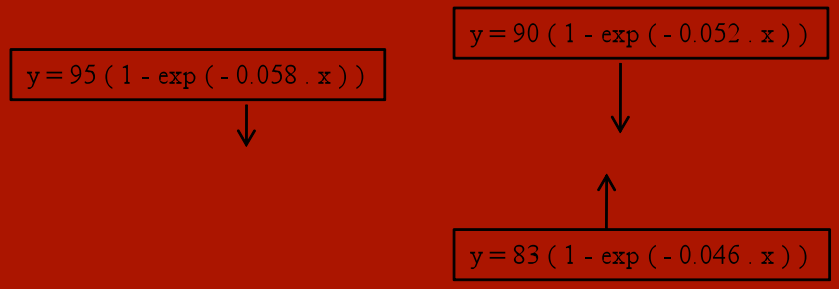
- **Materials**
  - **Vegetable oil from soybean, corn, etc**
  - **Oleaginous yeast, *Cryptococcus curvatus***

Experimental

- Cell disruptor horn is used to break open yeast cells for extraction of oil from oleaginous yeast
- Yeast cells mixed with a suitable solvent are sonicated at 370 μm_{pp}

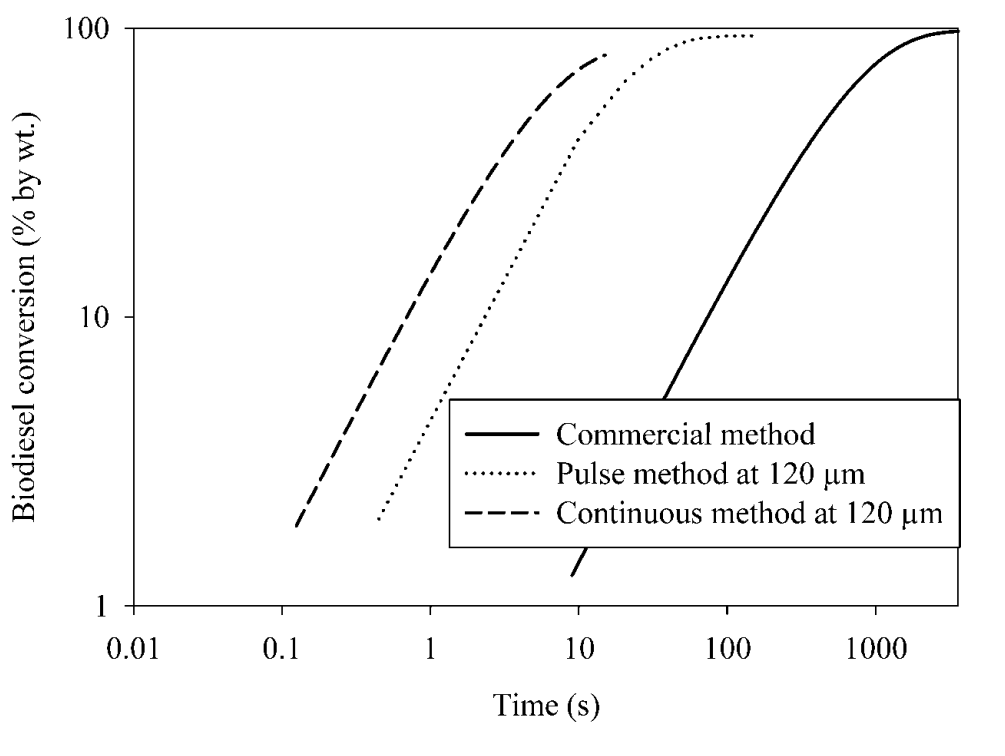
- Catenodial horn is used for aiding in transesterification of vegetable or yeast oil
- Oil is mixed with methanol and catalyst and sonicated at 120, 150 and 180 μm_{pp}

Results



- Pulse mode was used in which ultrasonics are ON for 5 s and OFF for 25 s
- Biodiesel yield of 95% by wt. was obtained at an amplitude of 150 μm_{pp} in total time of 2.5 min

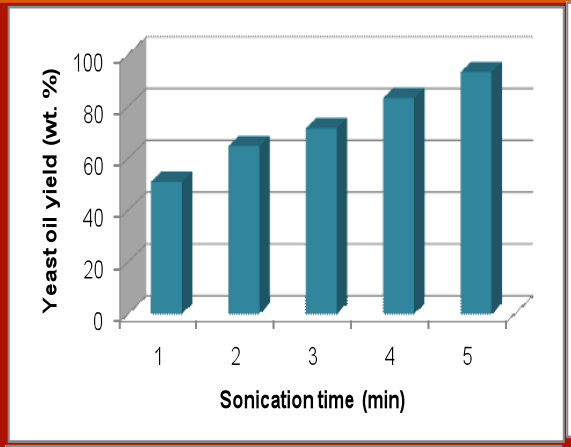
Results

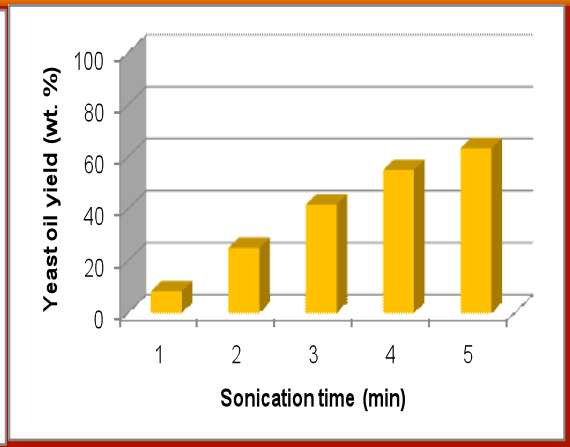


- Comparison of commercial, pulse and continuous method shows the difference in time required to get 95% biodiesel yield
- Application of ultrasonics during transesterification increases the reaction rate by a factor of 10

Results

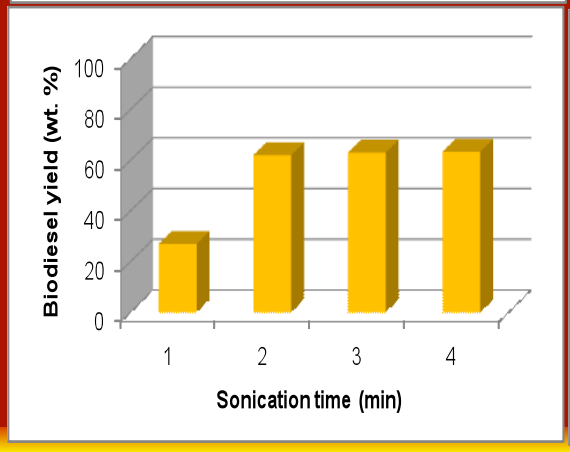
Yeast oil yield vs sonication time when oil is extracted from spray–dried yeast

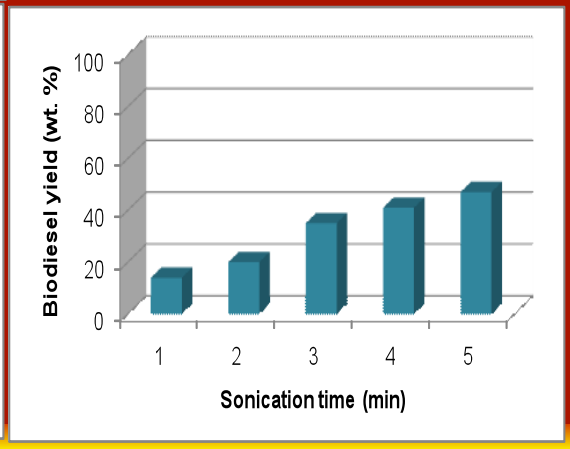




Yeast oil yield vs sonication time when oil is extracted from water–wet yeast

Yeast biodiesel yield vs sonication time for oil extraction from spray–dried yeast and subsequent conversion into biodiesel





Yeast biodiesel yield vs sonication time for simultaneous oil extraction and transesterification from spray–dried yeast

Conclusions

- Ultrasound can be used to increase the reaction rate of transesterification and reduce reaction time from 45 min to 2.5 min in pulse mode and 15 s in continuous mode
- Ultrasound can be used to efficiently extract oil from single celled oleaginous yeast
- Ultrasound can be an efficient method for simultaneous extraction and transesterification of oil from oleaginous yeast