2nd World Congress on Petrochemistry and Chemical Engineering

In situ transesterification of wet activated sludge under subcritical condition

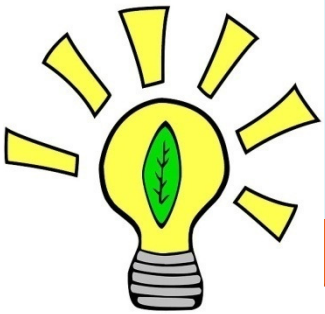
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Las Vegas, October, 27 – 29, 2014

Content



- Introduction
- Methods
- Results and discussion
- Conclusions



Objectives

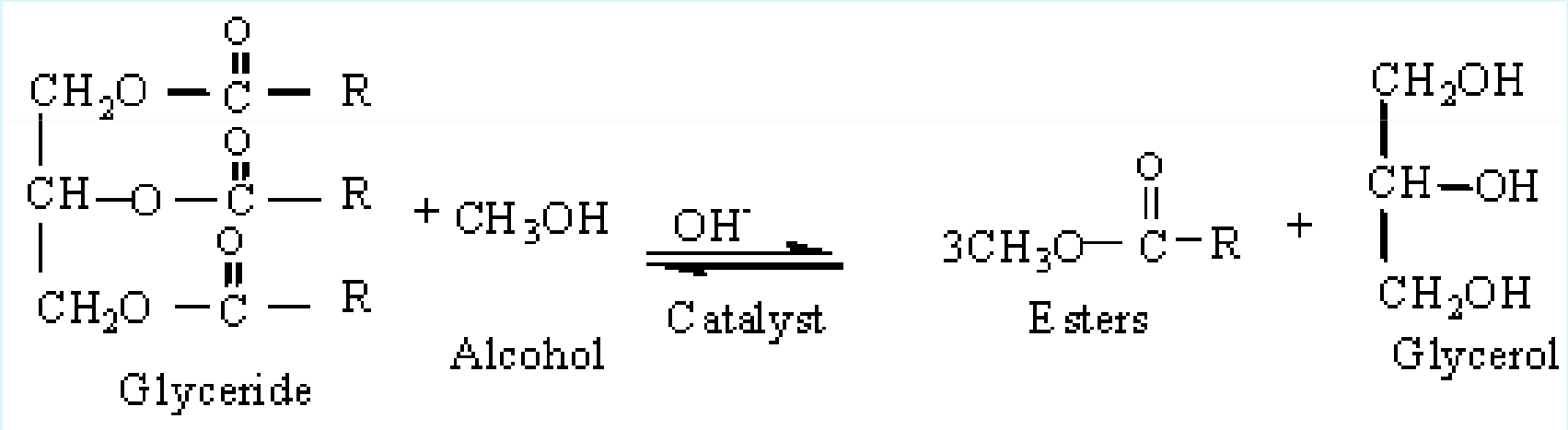
- In situ production of Fatty Acid Methyl Ester (FAME) without using conventional acid/base catalyst was investigated in this work.
- The effect of adding AA in methanol on FAME yield was studied with the objective of shortening the reaction time and reducing the amount of methanol required.





Introduction

1. What is biodiesel?



Source: www.esru.strath.ac.uk/EandE/Web_sites/02-03/biofuels/what_biodiesel.htm

2. Feedstock for Biodiesel ?



Corn



Soybean



Sunflower



Rapeseed



Palm fruit

3. Feedstock for Food and/or Fuels ?



?



?















Alternative Feedstock



www.examiner.com/article/waste-cooking-oil-re



http://www.scientificamerican.com/article/biofuel-from-bacteria/



www.popsugar.com/fitness/Skinny-Vegetable-Oil-75304



http://imgarcade.com/1/animal-fat-biodiesel/



Activated sludge (AS)

- AS is the product of a biological process and is a rich source of lipid.



Source: http://cen.acs.org/articles/90/web/2012/08/Biodiesel-Sewage-Sludge.html

It was estimated that drying and oil extraction constitutes more than 50% of the cost of biodiesel production from wet AS (Dufreche et al. , 2007)

Biodiesel production from AS

- Using a sulfuric acid catalyzed reaction with primary sludge as the feedstock, a maximum BD yield of 14.5% was obtained by Mondala et al., 2009.

- Revellame et al., 2010 achieved a BD yield of 4.79% by using a sulfuric acid catalyzed reaction in 24 h. The same authors also carried out the production of BD using wet AS (Revellame et al., 2011).

- Huynh et al., 2012 reported the production of BD from wet AS under subcritical condition without using conventional acid/base catalyst. The FAME yield was obtained about 80% in 8 h.

Subcritical water (SCW)

The development of environmentally friendly processes has become highly desirable for reasons such as pollution prevention, public acceptance and hazard elimination.

Water at subcritical state is a rich source of H^+ and OH^- → act as a neutral acid-base catalyst for extraction and chemical reactions.

Applied to the treatment of biomass from agriculture and industrial wastes such as activated sludge and micro-algae.

Methods

Materials

- FAME standard (47885-U, a mixture of 37 FAMEs) was purchased from Supelco (Bellfonte, PA).
- Standards of FFA were obtained from Sigma Aldrich Corp. (St. Louis, MO). All chemicals used are analytical reagent grade and were purchased from commercial sources.

- The AS sample was collected from a food processing plant (Hsin-Tung-Yang LTD Da-Yuan Factory, Taiwan) and was stored at - 84°C before use.

Experimental set-up

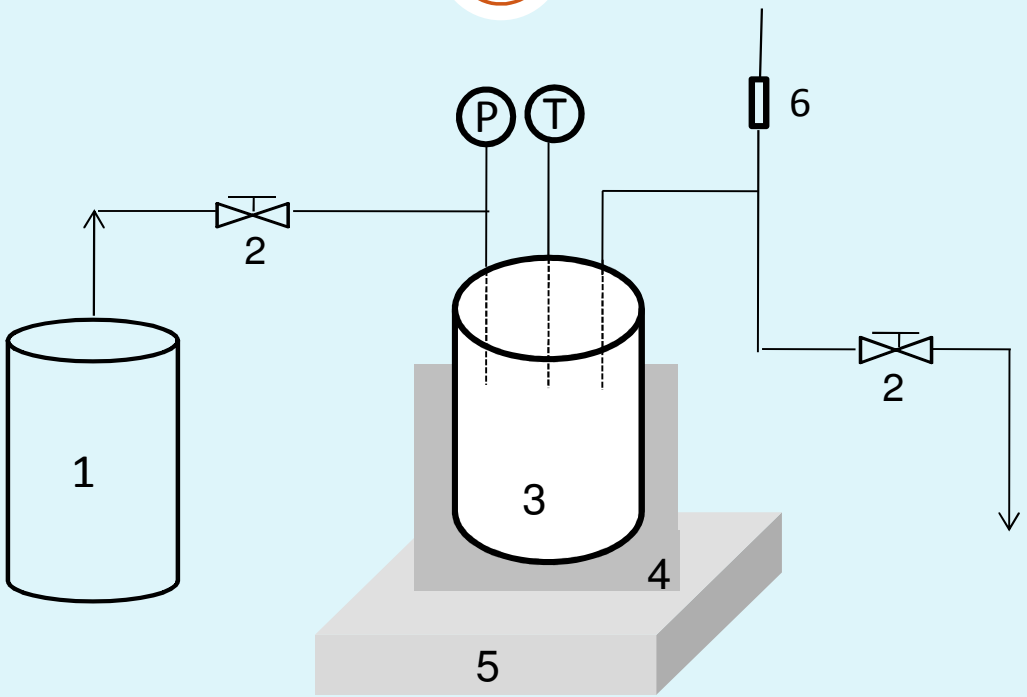


Fig. 1: Layout of equipments for SCW treatment and in situ reaction of wet AS. [1] N_2 cylinder, [2] needle valve, [3] reactor, [4] heater, [5] magnetic stirrer, [6] safety valve, [P] pressure gauge, [T] thermocouple.

Results and discussion

Characteristic of AS

Table 1. Crude lipid content in AS obtained by hexane extraction

	Weight percentage (wt.%) in dry AS	
	Before SCW treatment	After SCW treatment[a]
Unsaponifiable	0.50	5.75
Wax and gum	1.21	1.71
Neutral lipid	16.28	37.96

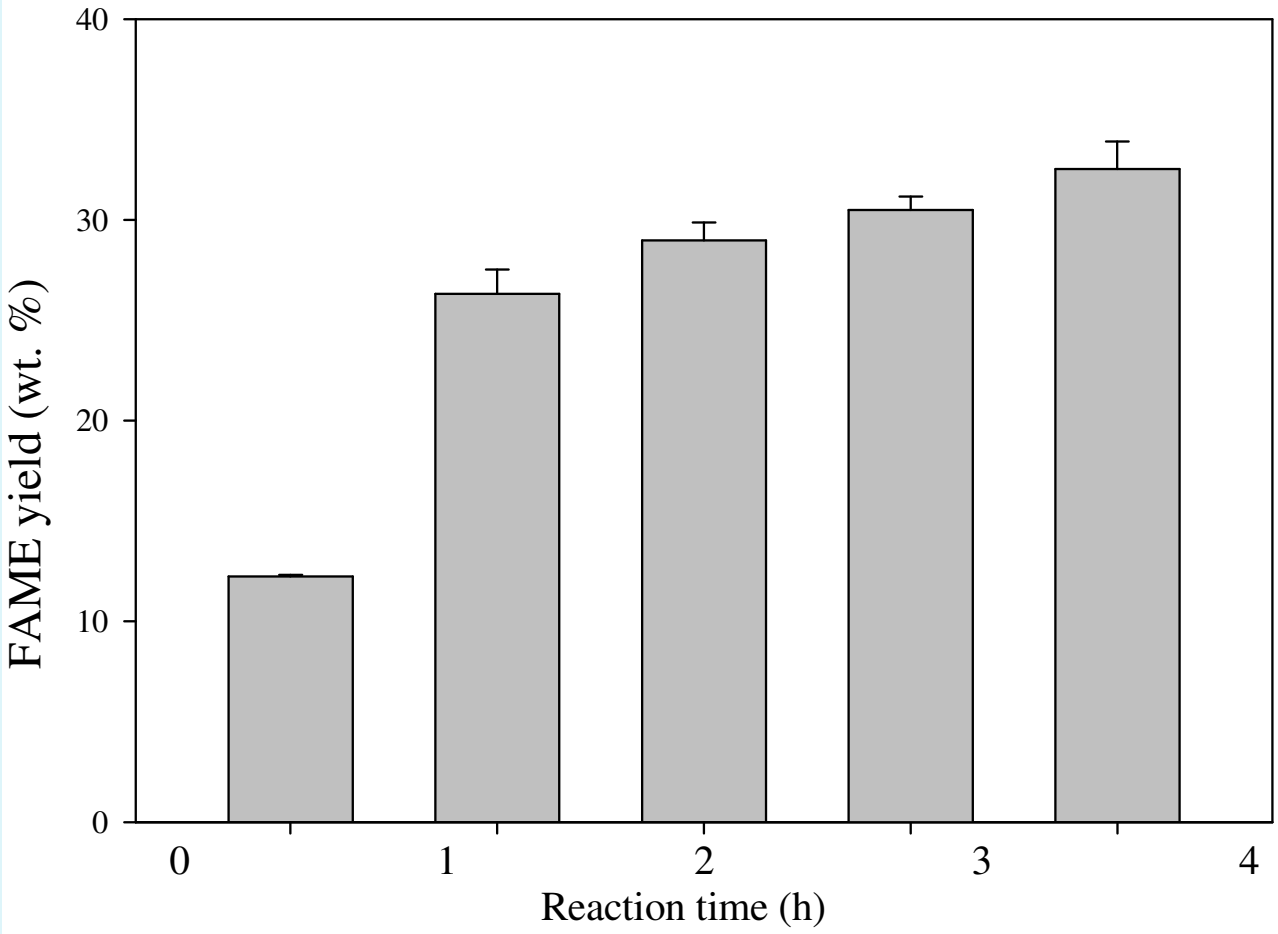
[a] SCW treatment of AS at 175 °C for 15 min

Characteristic of AS (cont'd)

Fatty Acid (%)	Without SCW treatment	With SCW treatment [a]
C12:0	0.23	0.24
C13:0	0.07	0.07
C14:0	1.87	2.03
C15:0	0.37	0.36
C16:0	46.2	50.4
C17:0	0.56	0.58
C18:0	30.5	31.6
C18:1	2.88	4.29
C18:2n6c	2.99	1.49
C20:0	0.94	0.96
C22:n	1.22	0.55
Others	12.1	7.5

[a] SCW treatment of AS at 175 °C for 15 min

Effect of reaction time on FAME yield



Reaction at 250 °C

Fig. 2: Effect of reaction time on FAME yield. Ratio of methanol to wet AS = 3 mL/g

Effect of acetic acid on FAME yield

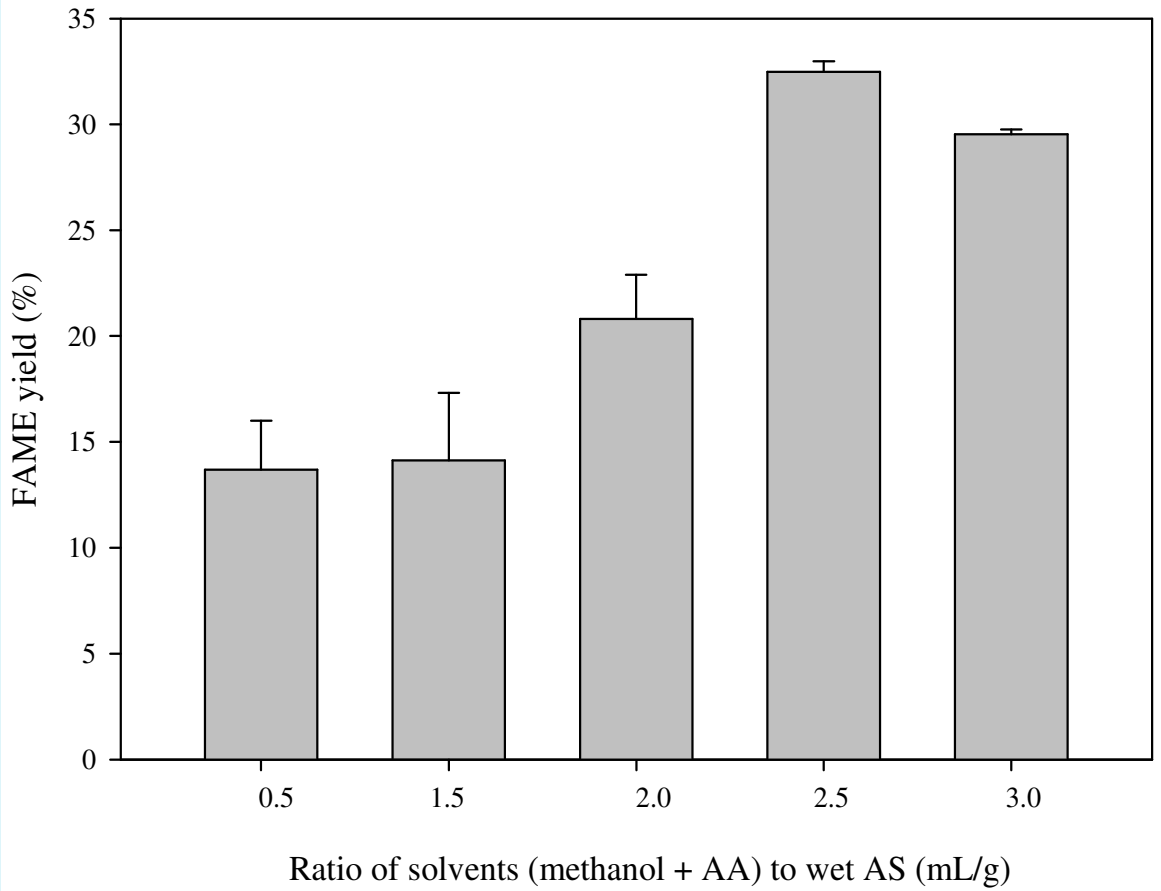


Fig. 3. Effect of ratio of solvent (methanol + AA) to wet AS on FAME yield. Reaction time 1 h, reaction temperature 250^{o}C

Acknowledgements

Many thanks to my labmates for their support.
This work was supported by the Ministry of Science and Technology of Taiwan through project NSC 102-2623-E-011-002 -ET.



Conclusion

This research investigated the effect of adding AA on FAME yield in the in situ production of BD from wet AS. By adding AA in methanol (10% AA in mixture) with a ratio of solvent mixture to wet sludge of 2.5 mL/g, an FAME yield of 33% based on dry sludge can be achieved in 1 h at 250 ^{o}C.


THANK YOU