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*Full Length Research Paper*

# Modeling of biodiesel reactor using fuzzy logic

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Abstract

**Transesterification reaction is reaction carried out by varying different parameters, like ratio of methyl alcohol to oil, amount of catalyst in reaction, temperature and stirring on the reaction; to find the beat conversion of oil to biodiesel. This reaction is replacement of alcohol group from an ester by another alcohol. Fuzzy logic is applied to the transesterification reaction studies and the result is compared with experimental results.**

**Keywords:** Biodiesel, transesterfication, reaction, rate-equation, parmeters, fuzzylogic.

## INTRODUCTION

Most common way to produce biodiesel is by transesterification which is catalyzed chemical reaction involving oil and alcohol to yield fatty acid alkyl esters like biodiesel , glycerol. Triglycerides, as main component of vegetable oil, consists of three long chain fatty acids .The triglyceride react with alcohol to yield fatty acid alkyl esters by producing glycerol as a byproduct. Methanol is most commonly used alcohol because its low cost. In general, large excess of methanol is used to shift the equilibrium far to the right (Figure 1).

## METHODOLOGY

Transesterification Experiment
Overall reaction involved in whole process;
Oil + 3 MeOH ⟷ 3 Biodiesel + Glycerol

### Experimental procedure

Jatropha oil is taken in a reactor and heated it 70˚C. This temperature is maintained through out the reaction by the thermostat inside the heat jacket. Preheating is used to remove moisture present in the oil.

Transesterification reaction is carried out in basic medium to achieve it KOH is used as a catalyst. This catalyst is dissolved in alcohol. When the oil temperature reaches 70˚C, alcohol solution is added to the reactor and equilibrium temperature is maintained. During the reaction alcohol gets vaporized. Condenser is used to condense the alcohol vapor and reflux it back in to the reactor to prevent reactant loss.

Once the reaction is complete products are taken out through the outlet of the reactor and put in separating funnel.

Two phases are found and results Transesterification reaction. Separation is done using separating funnel. Upper layer consists of Bio Diesel, alcohol, soap. No layer consists of glycerin excess alcohol, catalyst, impurities, traces of unreacted oil. Purification of upper layer is done in two steps:

I. Removal of alcohol – By keeping mixture at elevated temperature - 80˚C

II. Removal of saponified products – By washing with warm water, when water is immiscible with Bio Diesel, it can be easily separated from Bio Diesel.

### Experimental Setup

Reaction of Transesterification is carried out in reactor. Reactor consists of spherical flask, which is put in heat jacket. Oil is used as medium of heat transfer from heat jacket to reactor. Thermostat is a parkt of heat jacket, maintains temperature of oil at desired values, Reaction is carried out around 65 to 70˚C. Sperical flsk consists of 3 openings. The center one is used for stirrer in reactor.

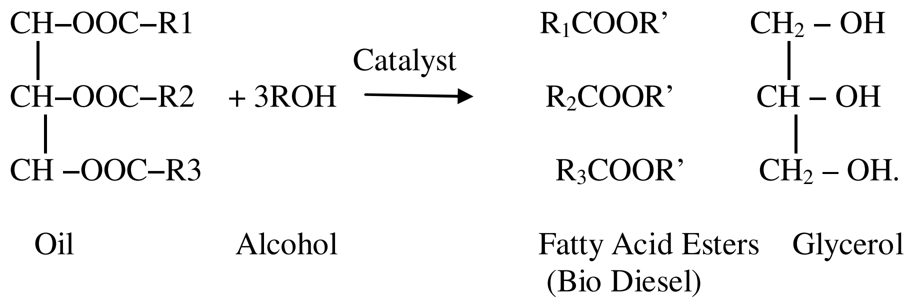


**Figure 1.** Transesterification Reaction

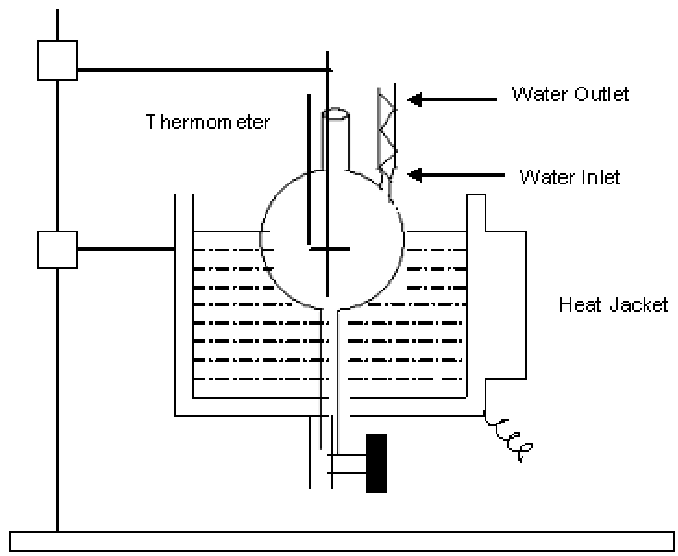


**Figure 2.** biodiesel production reactor

The motor propels the stirrer. Thermometer is put inside the second opening to continuously monitor the temperature of the reaction. Condenser is out in third opening to reflux the alcohol vapors back to the reactor to prevent reactant loss (Figure 2).

## RESULT ANALYSIS

### Parameters to be studied

**.**Variation of amount of catalyst in reaction .
**..**Ratio of methyl alchol to jatropha oil .
**...**Effect of temprature on reaction.
**....**Effect of stirring of reaction.

### Values of experimental observation:

- Jatropha oil :181 gm ; Methanol: 78 gm ;KOH 1 gm.
- Time 3 hrs;Temperature of reauction :65°C;Time for separation :24hrs .

### Effect of catalyst concentration on transesterification

Variation of KOH range from 0.25 gm to 1.5gm (Figure 3)

### Effect of amount of methanol on transeasterification:

Variation of alcohol range from 39gm per 181 gm of oil to 156 gm (Figure 4).

### Effect of temperature on Transesterification

Variation of temperature range 37$^o$C to 65$^o$C (Figure 5)

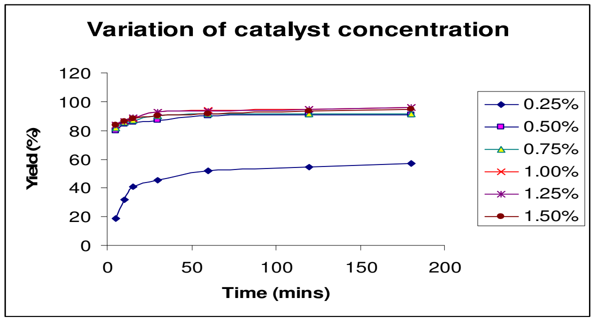


**Figure 3.** variation of catalyst concenttration

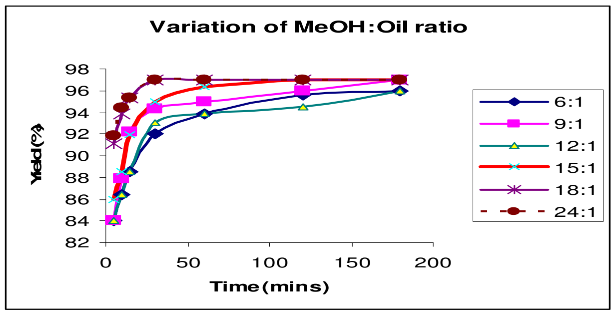


**Figure 4.** Variation of MeOH:Oil ratio

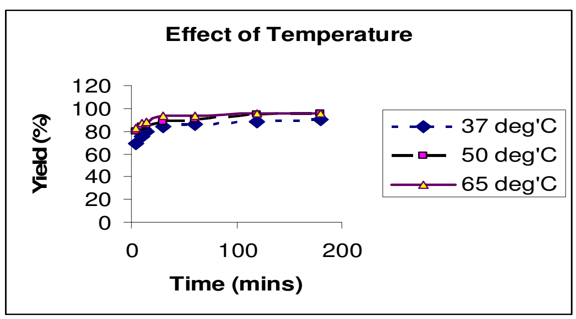


**Figure 5.** Effect of temperature

## Effect of stirring on trans-esterification

Variation of stirring is done from 180 rpm to 600rpm (Figure 6 and Figure 7).

## Modern software tolls

Many process simulation software packages incorporate data mining and analysis features are found underlying relevant relationships within culture data matrices both on and off line data process variables Key process variables need to be identified, e.g., Stirring, Temperature, Methanol-Oil ratio, Catalyst concentration. Their relationships with bioreactor performance (product yield) must be understood through comparisons with profiles from the large-scale process. Those relationships are then characterized as fully as possible and the operating ranges for their respective variables determined.

Since the number of process variables and data are often limited, neuro-fuzzy networks combine fuzzy logic and neural network technology allowing “expert rules” to be added to data sets for improving overall model robustness. That can be very useful in bioreactor processes where controlled variables are often restricted

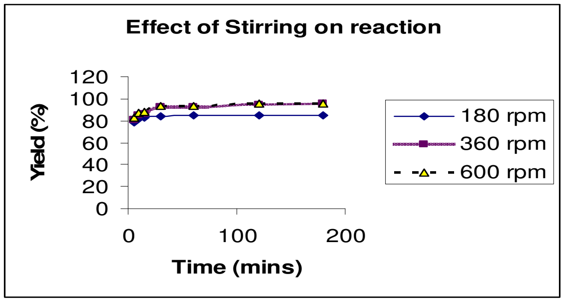


**Figure 6.** Effect of stirring

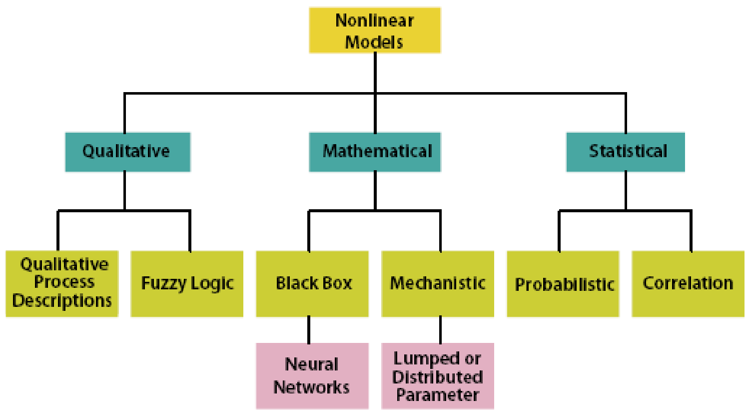


**Figure 7.** Classification of nonlinear model forms

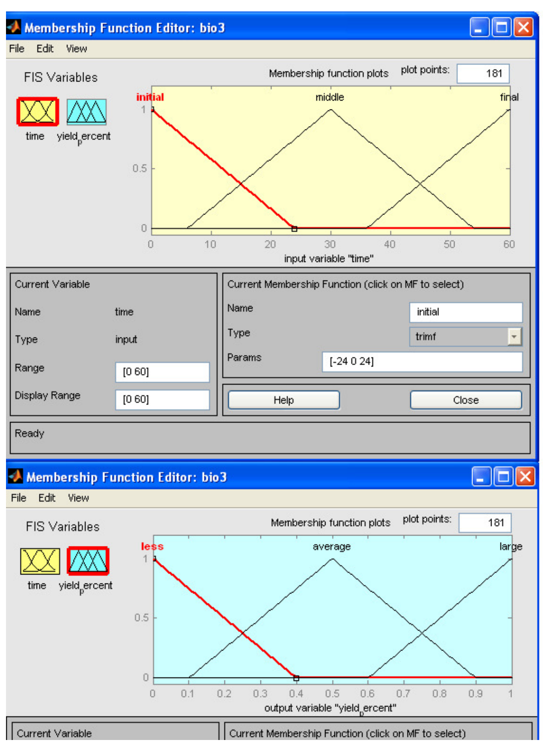


**Figure 8.** Fuzzy input and output variable modeling

**Table1.** Fuzzy Rule Base

| Time | Yield percentage |
|---|---|
| Initial | Average |
| Middle | Large |
| Final | Large |

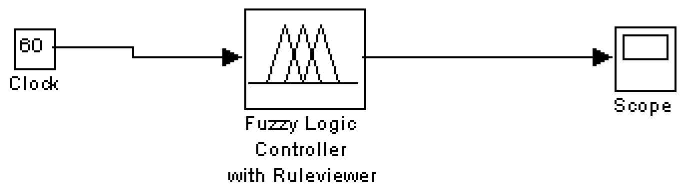


**Figure 9.** FLC for Bio Reactor

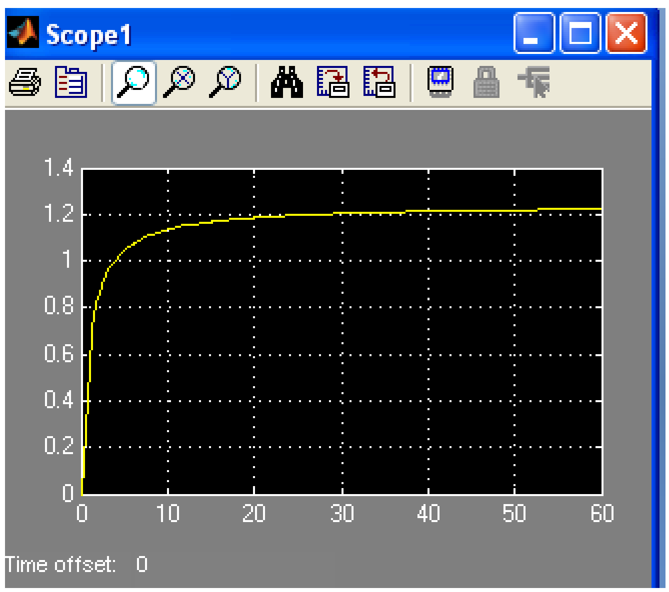


**Figure 10.** FLC predictor for bio reactor

to a limited range for design reasons (e.g., minimum or maximum achievable feed rates) or safety reasons (e.g., maximum allowable liquid volume height, vessel pressure, and so on).

The resultant FLC (Fuzzy Logic Controller) predicted the yield of biodiesel with considerable accuracy. The values obtained in the experiment were used for developing a model of biodiesel reactor using the advanced concept of Fuzzy logic. For this the experimental values of fraction of yield at different samples of time upto 1 hr were taken. Using these values we the fuzzy set time as input variable using triangular membership function was obtained. The rule base from the experimental values obtained in the production of biofuel was derived.

The resultant FLC (Fuzzy Logic Controller) predicted the yield of biofuel with considerable accuracy (Figure 8, Table 1, Figure 9, and Figure 10)

## CONCLUSIONS

Results in this study can be summarized as follows:

- The best time of reaction is 1 hr
- Optimum catalyst is 1.0 gm per 181 gm of oil.
- Optimum amount of methanol is 39 gm per 181 gm of oil.
- The prediction obtained using this FLC is accurate

with reference to the experimental results.

## REFERENCES

Christian J, William W (2007). "Bioreactor Monitoring, Modeling, and Simulation" Bio Process International :Supplement

Cortright RD, Davda RR, Dumesic JA (2002). Hydrogen from catalytic reforming of biomass-derived *hydrocarbons in liquid water.* Nature, 418:64-67.

Foidl N, Eder P (1997). Agro-industrial exploitation of *J. curcas*. In. Biofuels and Industrial Products from Jatropha curcas, Gübitz GM, Mittelbach M, Trabi M (Eds), Dbv-Verlag, Graz, Austria

Foidl N, Foidl G, Sanchez M, Mittelbach M, Hackel S (1996) *Jatropha curcas* L. as a source for the production of biofuel in Nicaragua; Bioresource Technol. 58:77-82

Honda H, Kobayashi T (2004). "Industrial Application of Fuzzy Control in Bioprocesses". Adv. Biochem. Eng./Biotechnol. 87:151–157

Ozturk SS (1995). "Engineering Challenges in High Density Cell Culture Systems. "Cytotechnol. 22(1–3): 3–15

Pramanik K (2003). Properties and use of Jatropha – curcas oil and diesel – fuel blends in Compression - ignition engine, Renewable Energy, 28 (2):239-248.

Report of the committee on development of Bio-fuel as formatted by the Planning Commission of India

Sastry SVAR (2005). Biodiesel Production : Lab Studies to Pilot Plant Studies, M.Tech Thesis, Department of Chemical Engineering, Indian Institute of Technology, New Delhi.

Srinivas M, Chidambaram M (1995)." Fuzzy Logic Control of an Unstable Bioreactor." Bioprocess. Biosyst. Eng. 12(3):135–139

Suresh Kumar, Gupta A K, Naik SN (2003). Conversion of non-edible oil into bio-diesel, J. Sci. Indus.Res. 62:124-132

Vivek provide initial??? A.K Gupta (2004), "Biodiesel Production from Karanja Oil", J. Sci. Indus. Res. 63:39-47