



Bioenergy - II: Fuels and Chemicals from Renewable Resources

UNIVERSIDADE FEDERAL DE PERNAMBUCO
CENTRO DE TECNOLOGIA E GEOCIÊNCIAS
DEPARTAMENTO DE ENGENHARIA QUÍMICA

PRODUCTION OF ETHYLIC BIODIESEL FROM HYDROLYSIS AND ESTERIFICATION OF ACID ANIMAL FAT

Jose Geraldo Pacheco, Ligia Martinelli;
Jadson Silva; Luiz Stragevitch



LAC-UFPE
Laboratório
de Combustíveis



UFPE

Donato Aranda



UFRJ

INTRODUCTION AND MOTIVATION

Feedstocks for biodiesel in Brasil

Low Acidity

- ❖ Soybean oil
- ❖ Tallow
- ❖ Palm oil
- ❖ Cottonseed oil
- ❖ Castor oil
- ❖ Sunflower
- ❖ Jatropha



INTRODUCTION AND MOTIVATION

Feedstocks for biodiesel in Brasil

Low Acidity

- ❖ Soybean oil
- ❖ Tallow
- ❖ Palm oil
- ❖ Cottonseed oil
- ❖ Castor oil
- ❖ Sunflower
- ❖ Jatropha

High Acidity

- Residues from edible oil
- High acid Tallow
- Residue from palm oil
- Waste Frying oil
- High acid Jatropha oil
- High acid Oiticica oil

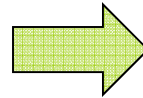


INTRODUCTION AND MOTIVATION

Biodiesel Production

Conventional Transesterification

- ❖ Acidity < 1%
- ❖ Dried feedstock
- ❖ Alkaline Catalyst



Biodiesel from High acid Feedstock

- ❖ Produce Soaps
- ❖ Decrease Yields
- ❖ Difficult separation
- ❖ More waste effluent

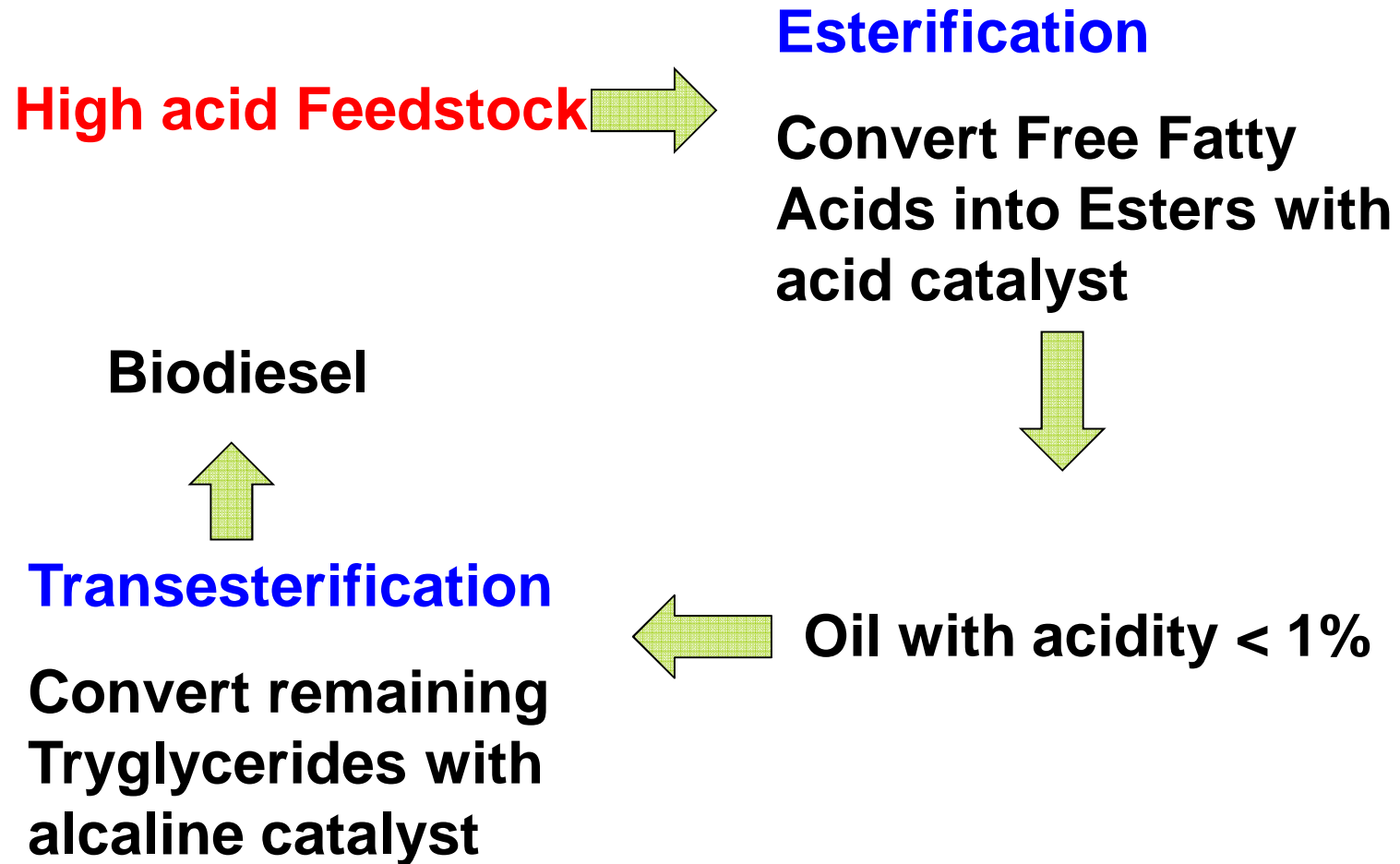




INTRODUCTION AND MOTIVATION

Biodiesel Production

Solution

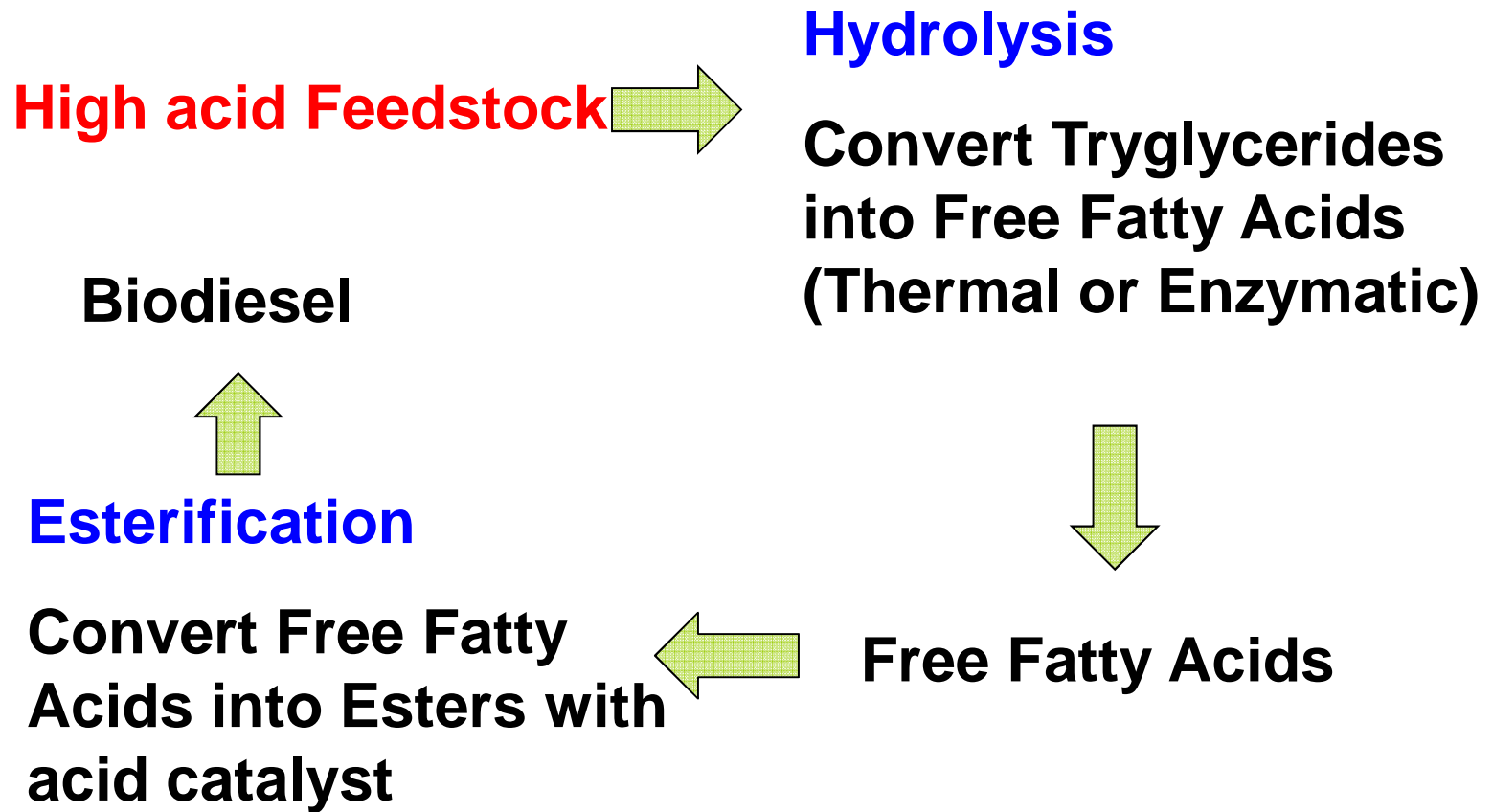




INTRODUCTION AND MOTIVATION

Biodiesel Production

Alternative Way



OBJECTIVE

Produce biodiesel from hydrolysis of high acid beef tallow followed by esterification reaction with ethanol and acid catalyst

Residue Beef Tallow

Ethanol

Hydrolysis

Esterification





Table 1 Fatty acid composition of beef tallow
 Carbons in the chain:double bonds. Zheng and Hanna (1996).

Beff Tallow

Fatty acid composition of beef tallow

Acidity: 10% of Free Fatty Acids

Fatty acid	Systemic name	Formula	Structure ^a	wt% this work	wt% Zheng ^b
Miristic		$C_{14}H_{28}O_2$	14:0	5.1	4.8
Palmitic	Hexadecanoic	$C_{16}H_{32}O_2$	16:0	28.7	28.4
Palmitoleic		$C_{16}H_{30}O_2$	16:1	3.2	4.7
Stearic	Octadecanoic	$C_{18}H_{36}O_2$	18:0	14.4	14.8
Oleic	cis-9- Octadecenoic	$C_{18}H_{34}O_2$	18:1	48.6	44.6
Linoleic	cis-9,cis-12- Octadecadienoic	$C_{18}H_{32}O_2$	18:2	--	2.7

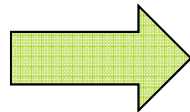
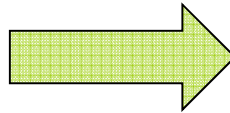
ENZYMATIC HYDROLYSIS OF TRYACYLGLYCEROLS



Castor seed



Tallow



40°C
30% WATER
20% Seed

HYDROLYSIS



Time (h)	Experiment					
	1		2		3	
	Acidity (%)	Conv. (%)	Acidity (%)	Conv. (%)	Acidity (%)	Conv. (%)
0	6,50	0	6,70	0	6,60	0
0,5	26,36	75,34	24,19	72,30	24,17	72,69
1	37,64	82,73	42,43	84,21	32,10	79,44
1,5	33,69	80,71	49,76	86,54	40,91	83,87
2	38,45	83,09	52,86	87,33	41,88	84,24
3	-	-	53,19	87,41	-	-
4	-	-	56,53	88,15	-	-
24	-	-	73,89	90,93	-	-

ESTERIFICATION



1h

70°C - 130°C

500 rpm

0.2% - 0.8% H₂SO₄

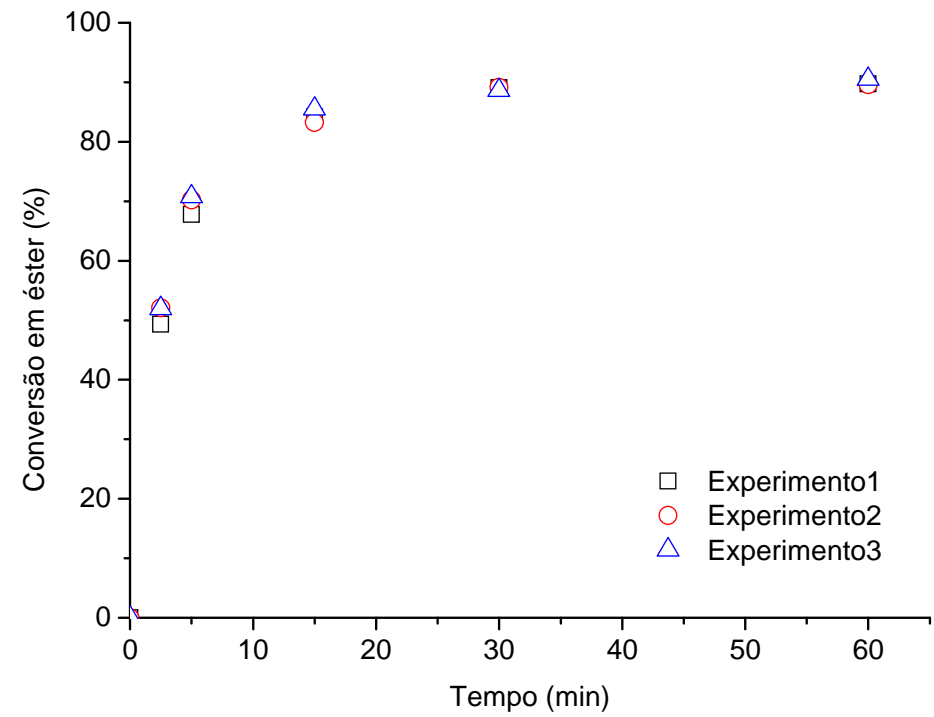
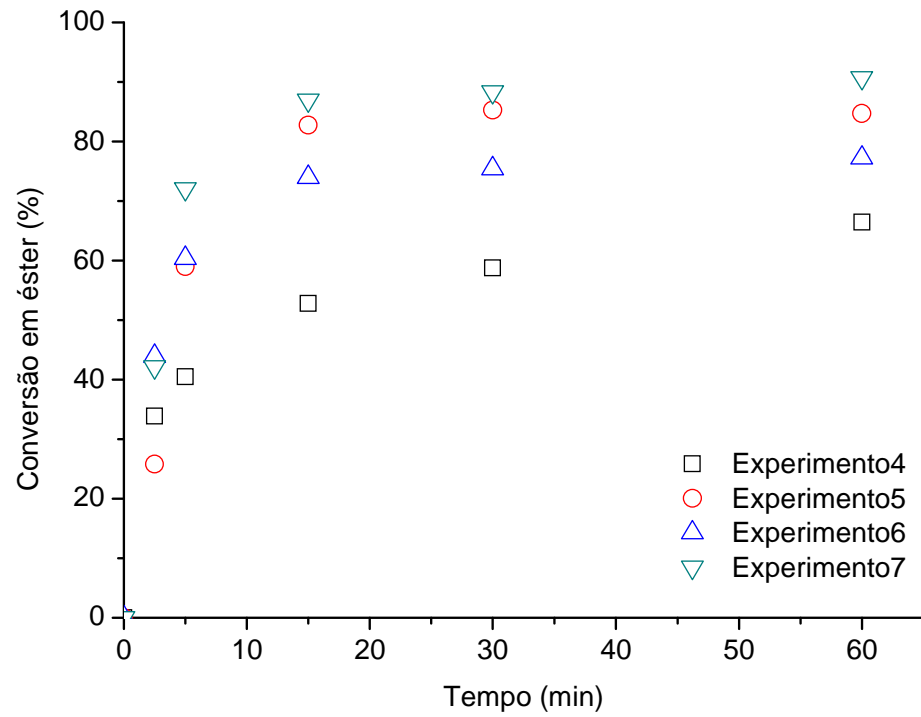
Alcohol/Oli 5:1 – 9:1

Pressure 80 psi

ESTERIFICACION

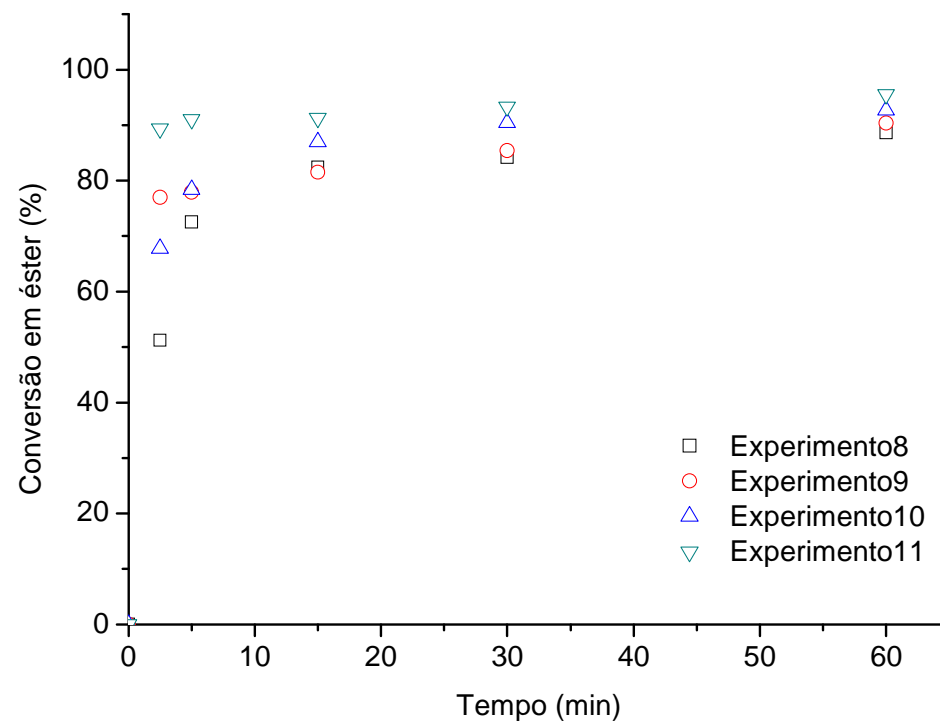
70°C

100°C



ESTERIFICACION

130°C





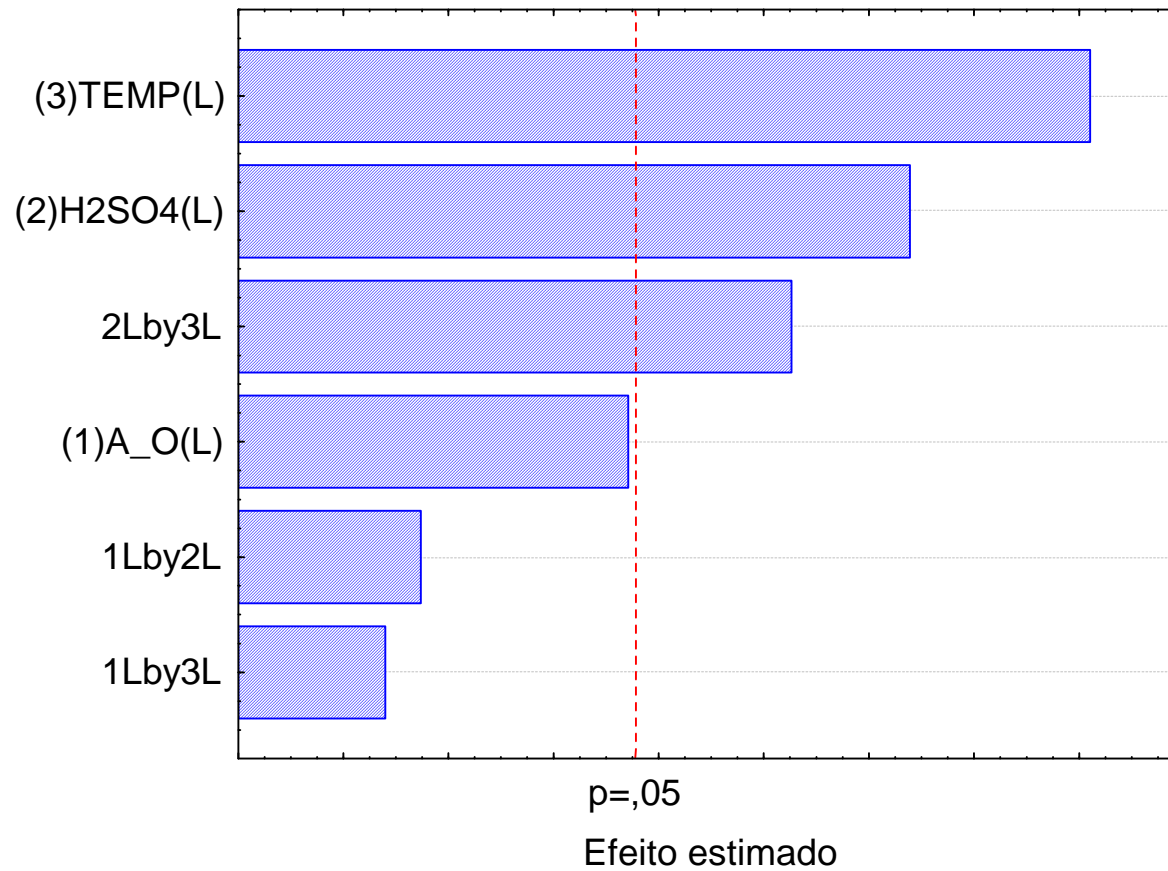
ESTERIFICATION

Effect of Variables on Conversion

Média	85,6
Efeitos 1 (álcool/óleo)	5,4
Efeitos 2 (Catalisador)	10,8
Efeitos 3 (Temperatura)	14,3
Efeito da Interação 12	-1,5
Efeito da Interação 13	-0,8
Efeito da Interação 23	-8,6

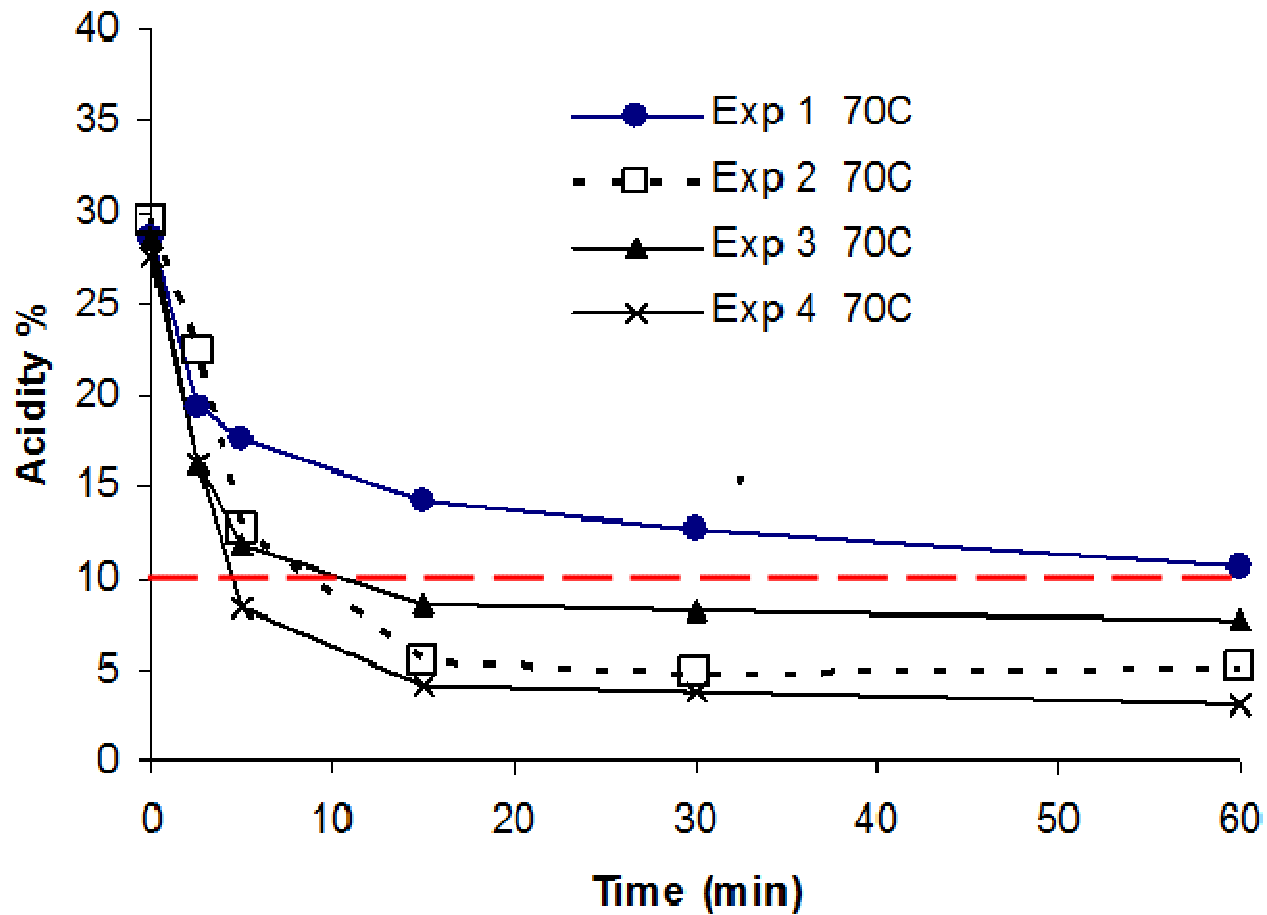
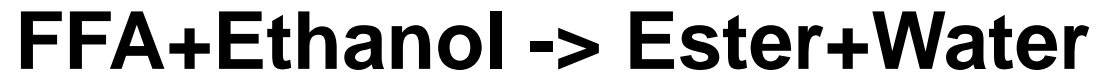
ESTERIFICACION

Effect of Variables on Conversion



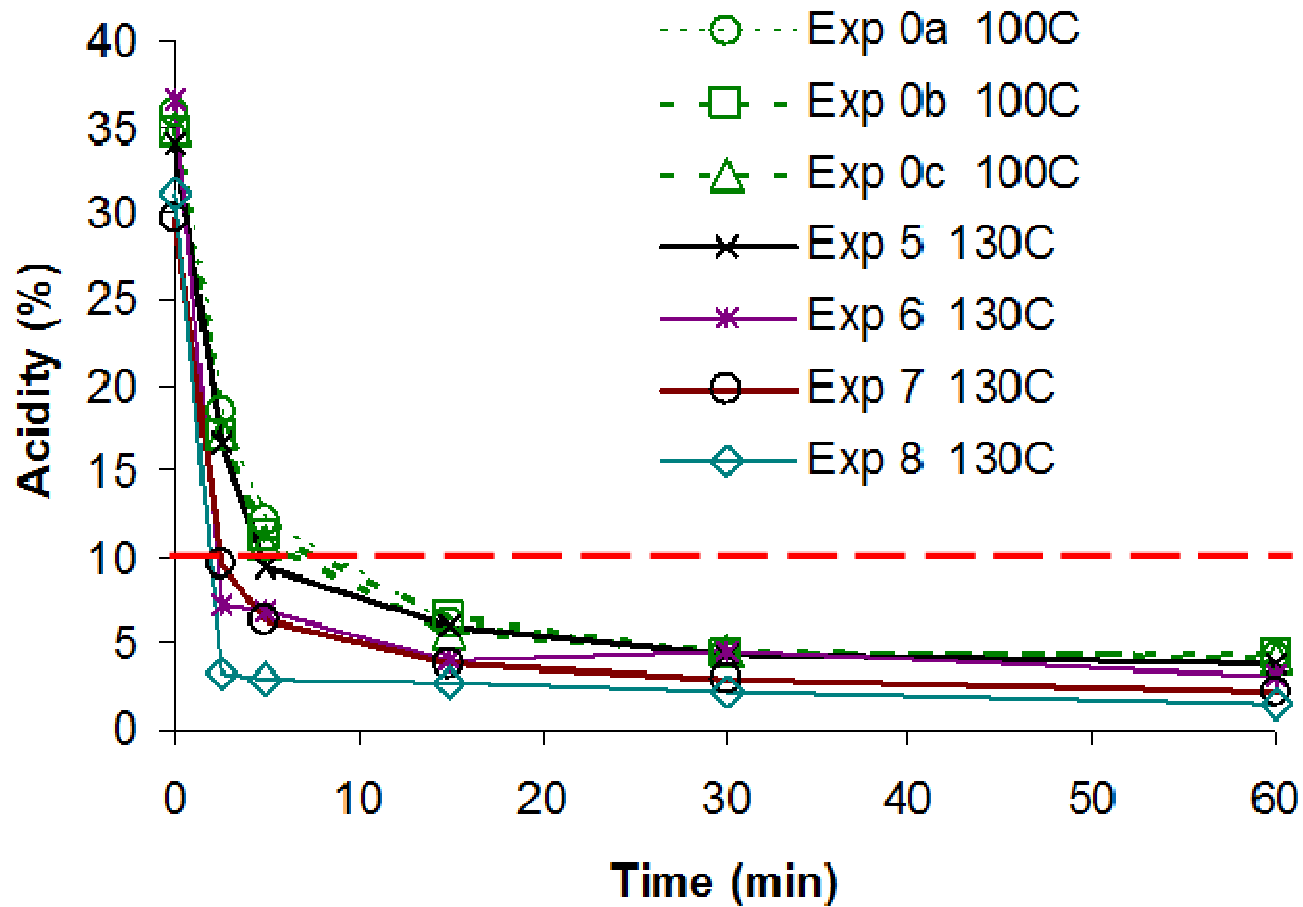
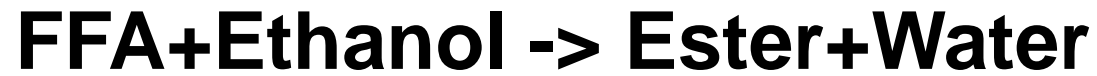


ESTERIFICATION



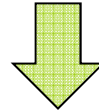


ESTERIFICATION

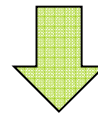


ESTERIFICATION

In 02 Steps at 100 C



Separation and Purification



Biodiesel

Property	Result	*Specification (Biodiesel)
Massa específica a 20°C (kg/m ³)	878.3	850 to 900
Viscosidade cinemática a 40°C (cSt)	5.4	3.0 to 6.0
Índice de acidez (mg KOH/g)	0.36	0.50
Ester Yield	96.6%	> 96%



CONCLUSIONS

- ❖ **Biodiesel from acid feedstocks is a need in Brazil**
- ❖ **Ethylic Biodiesel is preferable**
- ❖ **Enzymatic Hydrolysis followed by Esterification is a promise alternative**
- ❖ **Other acid feedstock can be used: Oiticica, Jatropha, Used Frying Oil**