AVAILABLE TECHNOLOGIES AND MATERIALS FOR WASTE COOKING OIL RECYCLING TO CONVERT THEM INTO BIODIESELS

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Abstract

In these days, the progressive depletion in petroleum resources in combination with environmental problems associated with the use of fossil fuels, in addition to stringent exhaust regulations have prompted the development of new ecologically clean energy sources, at lower costs to meet the world's energy needs while preserving the environment. In this regard, the use of biodiesel has emerged as the most feasible solution to accomplish this challenge. Such an alternative, which is cleaner than oil and is produced from biomass, ensures the reduction of oil consumption as well as greenhouse emissions.

From an industrial perspective, the simple chemical composition of WCOs make them suitable as valuable chemical building blocks, in fuel, materials, and lubricant productions.
The sustainability of such applications is sprightly related to proper recycling procedures. In this context, the development of new recycling processes, as well as the optimization of the existing ones, represents a priority for applied chemistry, chemical engineering, and material science. With the aim of providing useful updates to the scientific community involved in vegetable oil processing, the current available technologies for WCO recycling are herein reported, described, and discussed

In this work, we have synthesized biodiesel from WCO using the transesterification technique. We present environmental and economic benefits from the use of biodiesel, and the impact on the improvement of qualitative indicators of the amount of biodiesel added to fossil diesel. The purpose is to maintain constant engine performance, due to changes beginning with the influence of the quantity of fuel to power motor, fuel consumption and thermal efficiency.

As a renewable, sustainable and alternative fuel for compression ignition engine, biodiesel instead of diesel has been increasingly fuelled to study its effects on engine performances and emissions in the recent 15 years.

Keywords: biodiesel, diesel, WCO, environment, transesterification.

1. INTRODUCTION

The high-speed growth of the global population leads to drastically increasing demand for a sustainable energy supply also turning the attention to waste treatment. Demand for energy is progressively increasing and current energy sources are limited, researchers are always looking for alternative energy sources. (Wolfram, C., Shelef, O. & Gertler, P. J. (2012))
Another reason, even today, is the drastic increase in oil prices as a result of finite energy sources for fossil fuels and environmental concerns have led researchers to seek alternative energy sources, and in particular biodiesel sources.

Biodiesel promises to be one of the most potential and most potent energies it is also a source of clean fuel as it emits less toxic pollutants and greenhouse gases than diesel fossil. Biodiesel can be used as a single fuel or mixed with conventional diesel. It is also proven in previous works that Biodiesel is suitable for diesel engines without the need for any particular modification and has not resulted any negative impact on engine performance.
Biodiesel presents many advantages over fossil diesel such as renewability, sustainability and biodegradability.(Zhang, Y. 2003)
Without eliminating the need for sustainable energy, the issue of global pollution is also important to be discussed. One of the most trendy and key ways to reduce pollution is waste recycling, turning them into important products. (M. Zabeti,2009)

Referring to a large number of studies we see that they are focused on biodiesel production with ante of transesterification of vegetable oils with alcohol under different reaction conditions. The transesterification reaction is carried out in the presence of acidic or basic catalysts. It has been found that there are disadvantages when using acid / base catalysts. Firstly, alkali catalyzed processes are very sensitive to the presence of free fatty acids (FFAs) and water. In this case, the reaction causes us to form soap, reducing the rate of biodiesel production and resulting in cleaning difficulties. The second reason is that acid catalyst processes refer to a long reaction time. (Demirbas, A. (2009))

Esterification and transesterification processes are the most popular processes for biodiesel production. The general reaction is referred to in **Figure 1**.

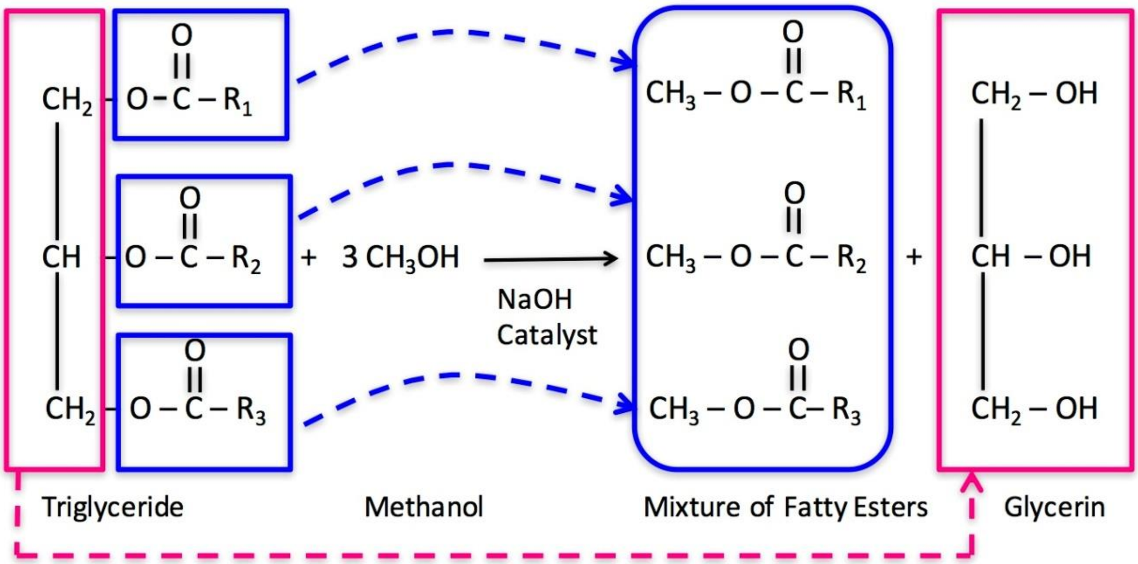


Figure1: Transesterefication reaction of triglyceride by methanol with alkaline catalyst

The required product of this reaction is methyl ester (biodiesel), while the main sub-product is glycerol. Methanol is one that is mainly used as a low cost reason. The residues produced by the biodiesel production process are mainly water from the purification process, and the residues of the catalysts and the alcohol that they often return to the recycling process.

1.1. Simulation by Aspen

Aspen Hysys's and Plus application uses the basic concepts and their connection among them, for example, mass and energy compensation, to evaluate how to perform a complex procedure. The Aspen principle gives engineers the ability to describe and test a synthetic process in a short time.Furthermore , it can be used to explore the impacts of diverse configuration parameters of the synthetic process and give comes about that are hard to acquire in research center.

By utilizing thermodynamic testing information and practical working conditions, the actual behavior of the process can be re-implemented.

Also, the reenactment transformation empowers the architects' methodology to grow the best methodologies using the device, for example, affectability probe, adding the machine square, expanding parts, benefit analysis, and special outline. Aspen methodology application can be utilized by the following steps (Aspen technology (2009)):

Step 1: Identify the unit operations and the procedure streams that stream to and from them in the process flow sheet. Name all streams and associate them to the unit operation models.

Step 2: Identify the substance columns from the Aspen Hysys database or define them .

Step 3: Identify thermodynamic models incorporated with Aspen Hysys to meter the physical properties of the parts and mixtures simultaneously.

Step 4: Identify the thermodynamic conditions and the part stream rates of the info streams.

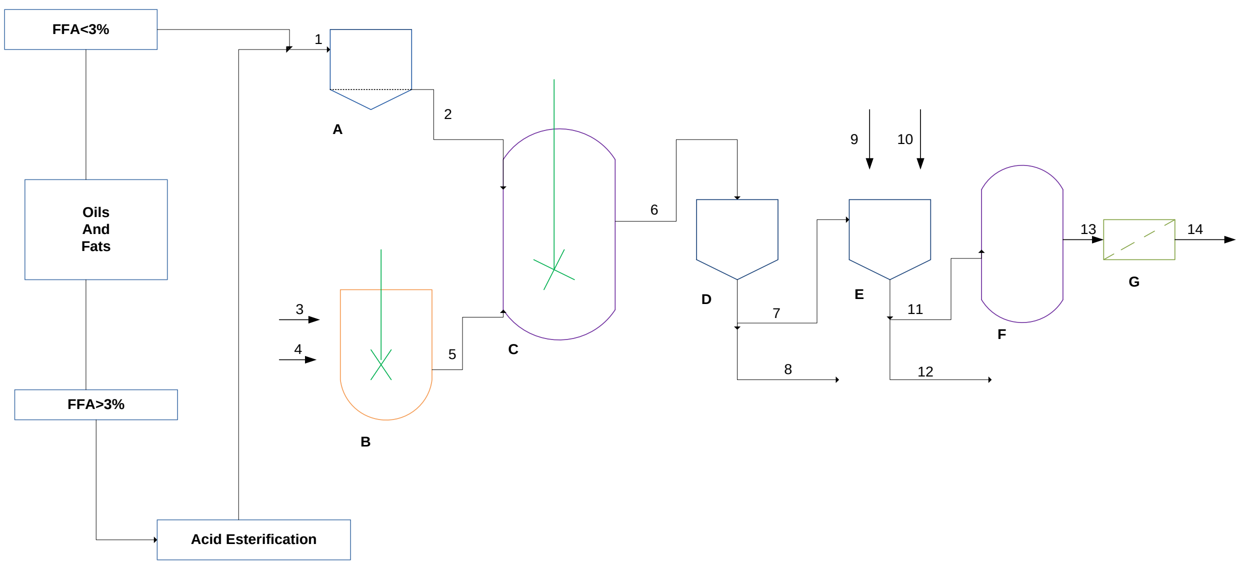
Step 5: Identify the working conditions for the unit operation models.

We can change most of the above information details to distribute options forms. Additionally, Aspen Plus can be used to customize plant information with reproduction models to predict and restore physical properties, generate even deliver results, and interface results in spreadsheets. In this enterprise, different models are in contrast to biodiesel production and the parameters have improved so the greater transformation and the least warmth obligation is taken. Now, for the trans-esterification reaction, let's look at different models for studying.

RESULTS AND DISCUSSION

The program used for simulation is Aspen plus v10. Also block schemes are built according to the vision 2017 program. In the following schemes are given some alternatives that we have worked with to reach the optimum scheme for Biodiesel production.

Figure 2 : block simplified scheme of alkali-catalyzed biodiesel production



A: Filtering and heating tank reactor for Oil and fats
B: Blender
C: Transesterification stirring tank reactor
D: Settler 1
E: Settler 2 (Biodiesel washing process)
F: Tank reactor for biodiesel drying
G: Filtration Unit

1: Untreated oil and fats
2:Treated oil and fats
3:Methanol
4:Sodium hydroxide
5:Methoxide solution (methanol+NaOH)
6:Reaction products
7:Biodiesel+methanl+impurities
8:Glycerin

9: Hot Water
10:Citric acid 0.4%
11:Biodiesel+Water
12: Washing Water
13:Biodiesel
14:Final Biodiesel

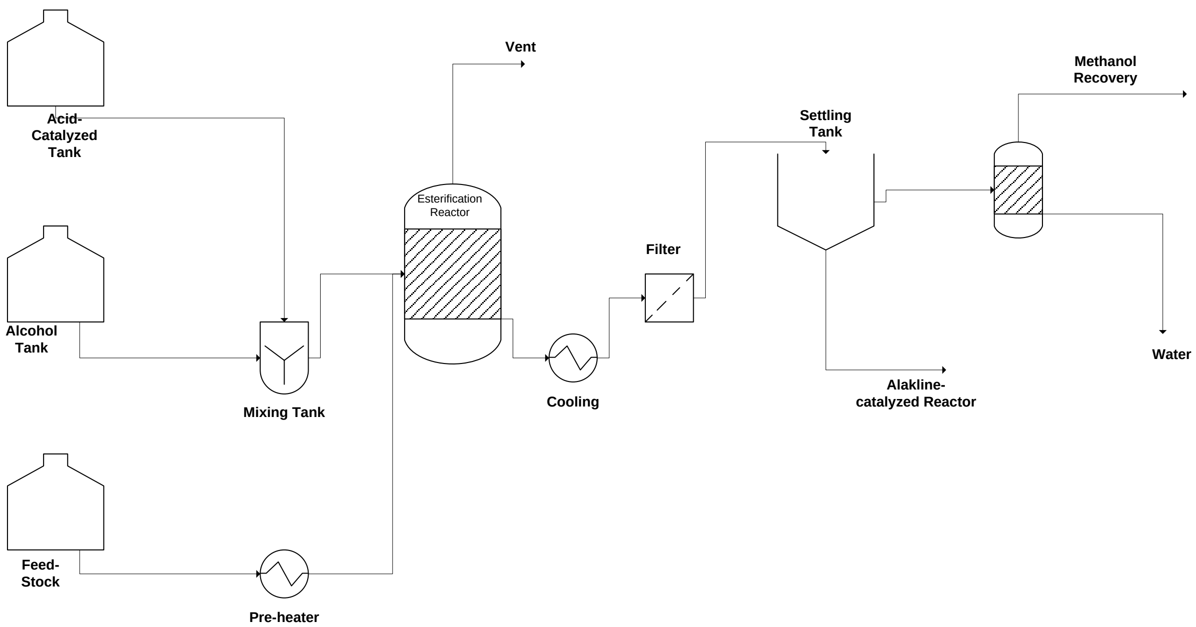


Figure 3: Pretreatment of high free fatty acid feed-stock with acid-catalyzed reactor—process

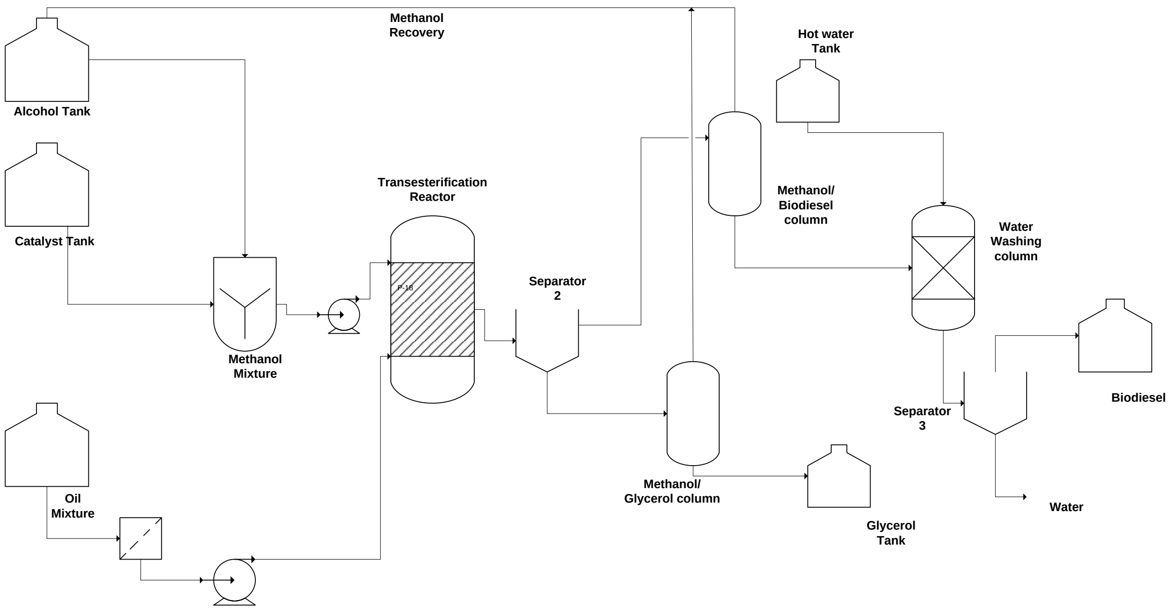


Figure 4: Alkali-catalyzed treatment of pretreated waste cooking oil—process

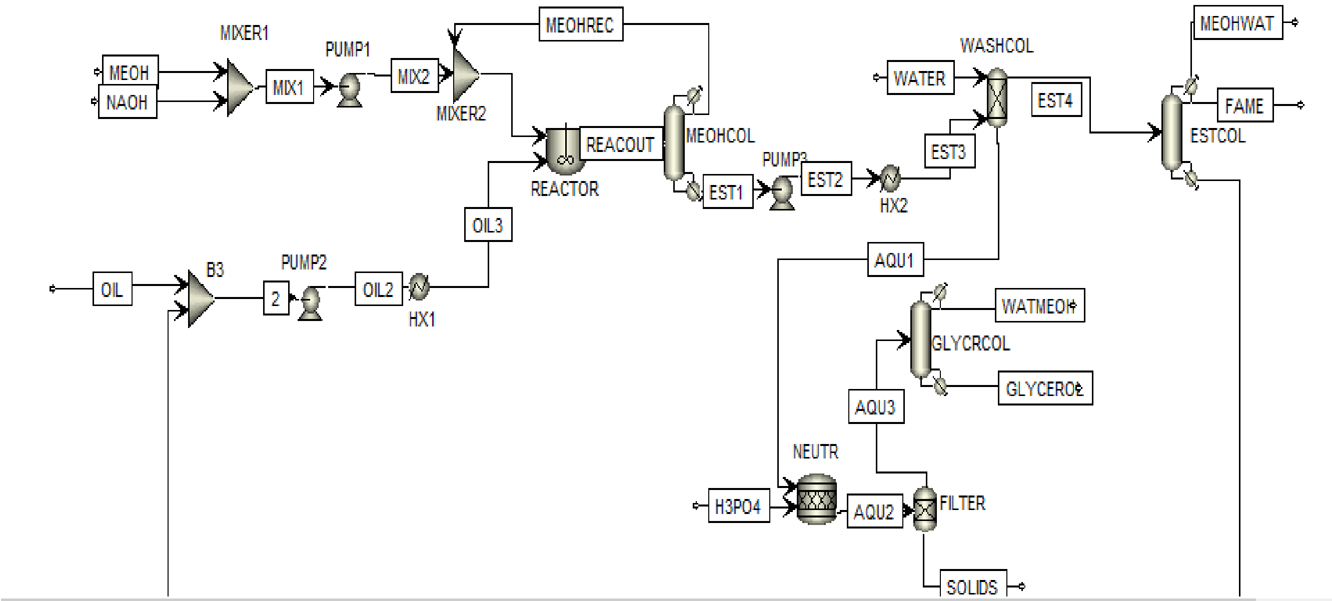


Figure 5: Process Flow diagram for Biodiesel plant in Aspen plus simulator.

The simulated continuous process flow sheet is presented below in Figure 5 . The process scheme can be described commencing with biodiesel synthesis and followed by the downstream processing steps to obtain pure biodiesel and glycerol products

From the general simulation scheme in the Aspen plus V10 program, we developed the separator tank V-101.

In the incoming stream we have WCO, catalyst and alcohol that have come from the Reactor where the transesterification reaction occurred.
We used experimental data developed at laboratory scale where the reaction took place under the following conditions: at a temperature of 150 F (65°C) at 1atm pressure.

Initially this operation was performed in an isothermal way using a decanter and an initial water sensitivity analysis out to ascertain the amount of water that can affect separation as well as allowing recycling. For this way of operation, an increase in water supplied to the led process to a reduction in the separating effect due to the existence of a homogeneous region, biodiesel, glycerine and water went out into a single stream. However in carrying out adiabatically, the division effect was discovered regardless of the amount of water used and glycerol was effectively derived from the ester phase.

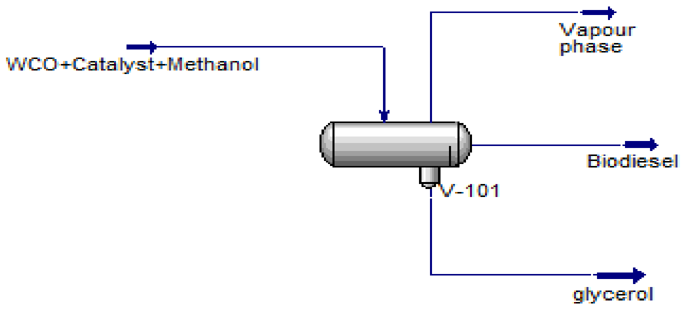


Figure 6 : Separation of Biodiesel and Glycerol

Table 1: Main Stream results of the simulated process and fraction compositions of Biodiesel production plant especially Separator Tank

Streams					
		WCO+Catalyst+Methanol	Vapour phase	Biodiesel	glycerol
Vapour Fraction		0.0000	1.0000	0.0000	0.0000
Temperature	F	150.0	150.0	150.0	150.0
Pressure	psia	15.50	15.50	15.50	15.50
Molar Flow	lbmole/hr	5.338	0.0000	1.931	3.407
Mass Flow	lb/hr	700.0	0.0000	590.3	109.7
Std Ideal Liq Vol Flow	barrel/day	52.77	0.0000	46.00	6.771
Heat Flow	Btu/hr	-1.116e+006	-0.0000	-6.019e+005	-5.145e+005
Molar Enthalpy	Btu/lbmole	-2.091e+005	-9.769e+004	-3.117e+005	-1.510e+005

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