Bio-ethanol producing possibility from waste glycerine

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Abstract

There is an effective and recommended way of using waste glycerol, as a byproduct during biodiesel production. It is processing through fermentation which brings into reality bio ethanol obtaining by the development of the valuable and different reactions and processes such as the anaerobic fermentation resulting except bio-ethanol also the succinic

acid as useful chemical compound. We have considered in this study, the processing of these waste glycerol derived by the biodiesel industry includes some steps. The need for these technological waste processing is important, not only for environmental reasons, but also for obtaining profitable chemicals that brings economic improvement, because from the biodiesel industry, a considerable amount of glycerol is produced as a secondary byproduct.

That is why it is meaningful to design or configure a treatment process tendentious for structuring a cycle which begins with the preparation of feed stream for the pretreatment of glycerol, followed by anaerobic fermentation producing ethanol and succinic acid. This process is then followed by the separation of desired products and later, Ethanol produced in that way was denatured with gasoline and reach a purity depending on final destination of the research.

The Aspen Plus computer software was used for process modeling and design. Through the simulation were firstly calculated mass, energy balances and also has been made the process economic evaluations. Main purpose of the simulation performed were establishing two different tentative flow sheets or process diagram, starting by treating the amount raw material of 1000 kg/h and 10000 kg/h, respectively.

Then we have compared the results of both types of technological schemes in order to find the most suitable and economical justified methods. All indicating parameters were strongly depended on the operational conditions defined by the predicted yield of the biodiesel production in Albania.

Keywords: process simulation, glycerin, bio-Ethanol, anaerobic fermentation, separation.

Introduction

Glycerol is byproduct of biodiesel industry and the amount of waste have become increasing by the timewhileits price is decreasing day by day. [1] The crude glycerol feedstock contains10% by mass glycerol. There are some different ways to treat the glycerol and in this work we have treat the way of the anaerobic fermentation of glycerol. The products of fermentation are bioethanol, succinic acid, hydrogen and carbon dioxide. [2] The manufactured ethanol can be considered a "green" or renewable fuel source. The plant proposed here is divided in three main sections which are: the preparation of crude glycerol feedstock, the fermentation section and the separation section. The section of feed preparation, include the cleaning, diluting and the sterilization of the crude glycerol that comes from biodiesel industries. In the fermentation section *E.coli* is used to ferment the glycerol in anaerobic conditions and then the products are separated in the next section. [3] The process is designed in Aspen Plus.The propose of this design is to examine advantages, disadvantages of this process by using economic analysis and material analysis of the Aspen Plus software. [4]

Materials and Methods

Materials

In this section we will briefly describe what equipment and materials have been used to design such a plant. The units used are storage tanks, heat exchangers, separators, distillation columns, absorption columns, dryers, pumps, furnaces, blowers. The equipmentare made of stainless steel 304. The materials that have been used are crude glycerol, CSL (Corn Steep Liquor), *E.Coli,* water, while the products are ethanol, succinic acid, carbon dioxide and hydrogen. To design our plant we have used Aspen Plus. Aspen Plus is the software that is used to simulate the material and energy balance of chemical processing plant. [4][5].

Feed preparation section: In this section the crude glycerol that comes from the biodiesel industry is treated diluting and sterilized to be suitable for the fermentation section. The glycerol that will be used as feed is byproduct of biodiesel industries and its composition will be depended by the oil that have been used as feed in the biodiesel industry (soya oil, sunflower oil, ect), it will be depended from the solvents that have been used and it will be depended from the rate of removal of ethanol during the biodiesel production process.

The typical composition of the feed, crude glycerol, is given in the table below where MONG is referred (Matter Organic, Non-Glycerol) where are included free fatty acids, monoglycerides and diglycerides. [6]

Table 1. The table of crude glycerol composition.

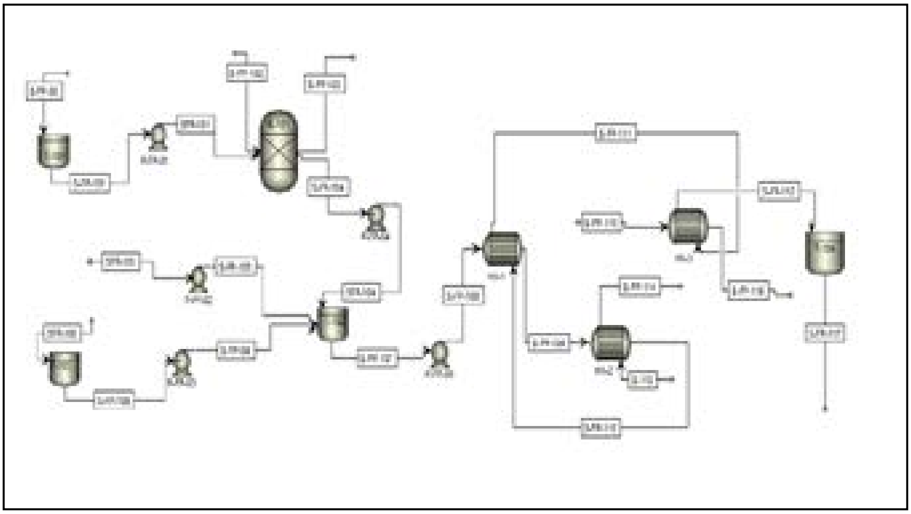
Material	Percentage
Glycerol	85 %
Water	7 %
NaCl	4 %
MONg	4 %

In this section we will add another element to the fermentation feed. In this section we will add CSL (Corn Steep Liquor) an inexpensive nutrient-rich byproduct of the wet milling of the corn. CSL contains variable concentration of salts, minerals, and amino acids to promote microorganism metabolism. The purification will be made by the combination of some processes such as reverse osmosis, electro-pressure membrane and electro-dialysis. [7]

The fermentation section

Fig.1 . The section of the preperation of glycerol

The fermentation section is divided in three stages which are the laboratory fermentation stage, plant fermentation stage and the main fermentation stage. The fermentation occurs first in lab scale and then in a plant because 1mL aliquot of cells cannot be added to the large fermenter



tanks. Optimal ph for the reaction is 7, optimal temperature is 37 °C and anaerobic conditions are required. [8] The required time to occur the reaction is 60 hours. The samples from the fermentation scale are added to the plant scale fermentation and will serve as source of E.Coli. In the main fermentation scale, tanks have large dimensions and these fermenters are charged with broth from the plant fermentation section which is reach in E.coli and also is charged with sterilized glycerol feed from the purification section. Laboratory section begins with the inoculum of 1mL E.Coli and the reaction and the conversions of glycerol are: [7][3]

Glycerol → CO_2 +H_2 + Ethanol (98%)

CO_2 +Glycerol → Acid Succinic + H_2O (1%)

Glycerol→ 3.0075 (Biomass) + H_2O (1%)

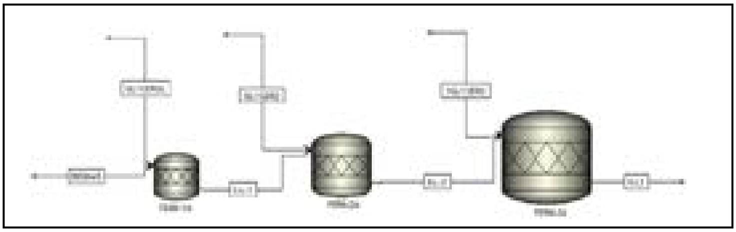


Fig. 2. The section of laboratory scale fermentation.

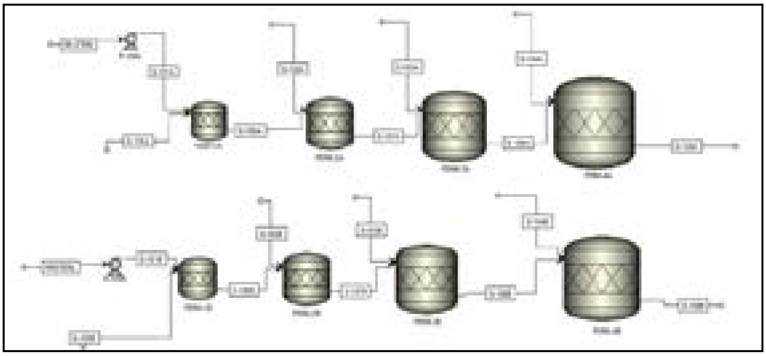
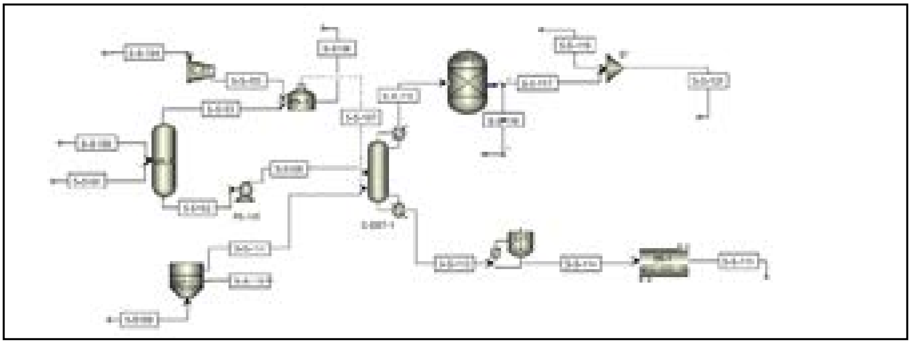


Fig. 3. The section of plant scale fermentation.

The separation section

Once the fermentation is complete, the broth is sent to the separation section of the plant. Ethanol from vapour stream from the fermentation section is absorbed in a colon and is sent to the distillation tower to be separated.[4] The dawn stream of distillation colon contain succinic acid and will be send to the crystallisation and then to dryer. The upper stream



contain ethanol and will be send to the separator to remove other elements to gain the desired purity and then will be denatured with gasoline.

Fig. 5. The section of product seperation.

1. Results AND DISCUSSION

In Aspen we have studied two examples of the operation of this plant by changing the flow. [9] In the first example we have applied a feed rate of 1000 kg/hr glycerol and in the second example we applied a feed rate of 10000 kg/hr. The results for the first example are not positive and do not interest us so we are presenting the results of the second example as can be seen in the tables 2 and 3.

Table 2. Material balances for the process.

PRODUCT	THE FLOW RATE
ETHANOL	2500 KG/HR
ACID SUCCINIC	157 KG/HR
CARBON DIOXIDE	2456 KG/HR
HYDROGEN	4 KG/HR

Table 3. Economic ananlysis.

	The preparation of feed	The plant scale fermentation	The main fermentation	Seperation
Total capital cost	407,000 $	10,000 $	1,043,100$	12,393,350 $
Total installed cost	1,334,300 $	59,700 $	2,445,200$	16,168,400 $
Total operated cost	914,350 $	914,350 $	914,315 $	914,350 $
Energy cost	8,25$/h	8,25$	8,25$/hr	8,25$/hr

2. Discussion

As we can see from the results the amount of produced ethanol is large but also the economic cost is large. The hydrogen produced by the fermentation will be used for the re boiler of column. Succinic acid is another favorable product from this fermentation. About the high cost of plant we can say the plants like that are more favorable where we have large amount of feedstock. The greater the amount of the feedstock the more effective this kind of plant will be. The dimensions of the tanks are large and this increase installation cost, operated cost and total cost.

Conclusions

Researching and building such facilities is the near future of waste processing, the future of a more ecological environment, and of course the near future of business that brings more revenue from low-cost materials.

Comparing the extremely low glycerol cost of 0.01 $/kg and the large amount of glycerol that is being produced as a secondary product from the biodiesel industry as well as the growing demand for bioethanol at a considerable price of 5.5 $ / kg we will undoubtedly say that the construction of this plant is very effective.

The main problem of this plant is that large quantities of fermentation tanks are needed and this has difficulties not only in their construction but also in the operation of the plant. Based on the simulation results for crude glycerol feed stream 1000 kg/hr the quantities of products obtained and the effectiveness of the plant are smaller compared to the 10000 kg/hr flow. For such plants we can say that the greater the food stream the more effective this plant will be. And finally to give an answer to the question of whether such a plant can be built in Albania we can *declare*: This plant is not suitable for construction in Albania because large glycerol feed is required. Albania does not have a biodiesel production industry so finding glycerol will be difficult and not at the desired cost interval.

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