Biomethanol Production from the Glycerol Byproduct of the Biodiesel Production Process, a Proposition

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Abstract. Currently, studies have been carried out with the objective of developing alternative fuels, which are sustainable and renewable. The proposal of this work is to present methodologies present in the literature that provide the conversion of glycerol to biogas and, from biogas to the production of biomethanol. Thus, to propose the study of a process plant, based on simulations and data obtained experimentally, to carry out the conversion of glycerol into biogas and convert the biogas into biomethanol. With the purpose of producing methanol from renewable sources. This work also proposes, the mass and energy integration in the biodiesel production plant, once, that the biomethanol produced can be used in the process itself.

Introduction

Among biofuels, biodiesel, as well as diesel, can be used in cycle engines, such as trucks, buses, etc. And, in stationary motors, as electric power generators [1]. Biodiesel has some advantages when compared to diesel, fossil fuel and non-renewable, such as: it is not toxic, it presents a lower gas emission index that contributes to the worsening of the greenhouse effect and can be obtained from renewable raw materials [2,3,4]. Besides the environmental advantages, biodiesel production also provides the socioeconomic advantage, since the productive chain generates jobs in different economic sectors.

Biodiesel can be obtained through the transesterification reaction of triglycerides or esterification of carboxylic acids, with alcohols, usually methanol or ethanol, in the presence of a catalyst [5]. When biodiesel is obtained from the transesterification process it produces as by-product glycerol, as shown in figure 1 [6].

![Figure 1. Global reaction of biodiesel production process via transesterification.](image_url)

In this way, the purpose of the work is to propose, from simulations, a plant that converts glycerol to biogas, later biogas into biomethanol. And that, this plant is coupled to a biodiesel production plant. In order to use biomethanol produced in the biodiesel production process. Thus, to perform a mass and energy integration in the system itself.
Production of Biomethanol

On an industrial scale, the methyl transesterification via homogeneous basic catalysis is the most used in the biodiesel production process [7, 8]. The commonly used alkaline catalysts are sodium hydroxide (NaOH) and potassium hydroxide (KOH). This is due to the low cost of these catalysts and the high conversion rates [9, 10, 11].

Methanol is the alcohol often used in the biodiesel production process. When compared to ethanol, methanol provides greater efficiency in both the speed and yield of the reaction. The use of methanol in the reaction to obtain biodiesel makes the separation of glycerol from biodiesel more efficient. Ethanol, in turn, favors the formation of an emulsion, making the separation process difficult.

Methanol, in the current context, causes biodiesel to partially escape the concept of green fuel, because it is produced mostly from natural gas. According to authors, the use of natural gas as raw material for the production of methanol is economically feasible, since this raw material presents low economic cost [12, 13]. In this way, it is interesting to look for alternatives for the production of methanol, which are: economically, technically and environmentally viable.

Biogas is formed mainly of methane (CH4) and carbon dioxide (CO2) produced from the degradation (biodigestion) of organic materials (biomasses). Biogas can be used as raw material (fuel) for the conversion of chemical energy into electrical energy. However, under ambient conditions, it becomes difficult to store and transport. Thus, studies have been carried out, with the objective of converting biogas into methanol. The conversion of methane to methanol is often carried out via thermochemistry. This process requires high pressure and / or temperature conditions and the use of chemical catalysts (usually with high added cost). Thus, some authors point out that the use of biocatalysts makes the process more attractive, both operationally and economically [14]. Segundo Patel et al. (2016) o biogás é uma das matérias-primas que podem ser aplicadas no processo de produção de biometanol. Esta matéria-prima apresenta baixo custo econômico, tornando-a atrativa. Os autores avaliaram o potencial de produção do metanol a partir de biogás bruto. O biogás bruto, utilizado no processo, foi obtido a partir da biodigestão de efluentes de uma estação de tratamento de esgoto. Concluem que a presença de H2S funciona como gás inibitório proporcionando baixa conversão de metano [15].

The work produced by Beschkov et al. (2012) proposes the production of biogas from the biodigestion of glycerol from the biodiesel production process. Biodigestion occurs in a multi-stage anaerobic biodigester. The microorganism used in the process is the bacterium of the genus Klebsiella. The authors conclude that despite the simple modeling the model can describe the competitive conversion of glycerol to biogas and butanediol. It is also possible to estimate the number of compartments necessary for the complete conversion of glycerol to biogas [16].

The work carried out by Baba et al. (2013) also proposes the production of biogas from large-scale anaerobic digestion. However, the authors highlight an important problem, the fate of the sludge generated after the glycerol biodigestion. The authors present as solution the use of this sludge as biofertilizer for pasture [17].

Justifications

currently, the production of biodiesel produces in parallel a large amount of glycerol, which subsequently undergoes processes of separation and purification (energy expenditure) to obtain pure glycerol. After obtaining the pure glycerin, it is commercialized, with low added value, being used mainly in chemical industries of cosmetics and cleaning.

In this way, the work has as main focus, to propose the conversion of glycerol (which is seen as by-product) in biogas (energy). Thus, the work will be divided into two stages: 1. Biomethanol production from the biogas produced through the glycerol obtained in the biodiesel production process, 2. Comparative energy analysis of the biogas use for the production of biomethanol versus for the generation of electricity.
Conclusion
From the literature review carried out in this work, it is possible to conclude that the proposal to produce methanol from biogas, being this biogas produced from glycerol, besides being attractive, has a consistent theoretical basis.

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References


