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On the search of efficient uses for glycerine: steam gasification

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Abstract. This work deals with the steam gasification of the glycerine generated during the biodiesel manufacture in an industrial plant. Glycerine (diluted in water) was gasified with the aim of producing an hydrogen-rich gas, making a systematic investigation on the influence of the gasification temperature in the range 600-1000 °C. It was found that the change in this parameter influences the composition of the gas generated during gasification, driving the process towards a higher hydrogen production as the temperature gets greater. On the other hand, if the aim is to produce a gas with a higher energy content, a lower temperature would be more favourable.

Key words

Glycerine, gasification, hydrogen, biodiesel

1. Introduction

Biodiesel is one of the alternative fuels used to meet the current energy requirements. Apart from the null net CO_2 emissions it provides, it can be used for automotive applications, which makes it more interesting than other alternative energy sources.

During biodiesel production by means of transesterification of oils and animal fats, glycerine is formed as by-product in a ratio of approximately 10% (weight referred to biodiesel production). This quantity of glycerin is huge if we consider that biodiesel production is increasing to get a more significant role in the next energy scheme. As more biodiesel is produced, the price of glycerin decreases and the need of searching new ways to provide an added value to this product becomes an imperative. With increased production of biodiesel, a glut of glycerol ($C_3H_8O_3$) is expected in the world market, and therefore it is essential to find useful applications for glycerol. Currently, glycerol is used in many applications including personal care, food, oral care, tobacco, polymer and pharmaceutical applications. However, explosive growth of biodiesel industry has created a glut in glycerol that has demeaned the market value of this commodity. Therefore, finding alternative uses for glycerol is important. One possibility is using glycerol as a source for producing hydrogen.

In this line, some studies regarding the steam gasification of glycerine for the production of hydrogen, syn gas and medium heating value gas have been made [1-9]. These works showed that glycerin steam gasification is a very complex process in which concurrent, consecutive, dehydration and cracking reactions all compete to transform glycerin into H_2, syn gas and char [1]. Theoretically, one mole of glycerin would give four moles of H_2. However, up to now, the most interesting results found in the bibliography show conversions lower than 60% [1], which is already very attractive.

Although this field is a hot topic for research, given the many advantages it can offer once the process has been optimized, the knowledge on the mechanisms governing glycerine degradation reactions is very scarce.
With these premises, this work studied the steam gasification of glycerine (diluted in water) with the aim of producing an hydrogen-rich gas, making a systematic investigation on the influence of the temperature (600, 700, 800, 900 and 1000 °C). The water-to-glycerol feed ratio and steam flow rate were 12:1 and 2.5 cm^3 min^{-1}, respectively.

2. Experimental

Glycerine was provided by the Biodiesel manufacture plant of Bioenergética Extremeña, located in Valdetorres (Extremadura, Spain).

The runs were performed under continuous regime, using a two stage gasification system as the one shown in Figure 1.

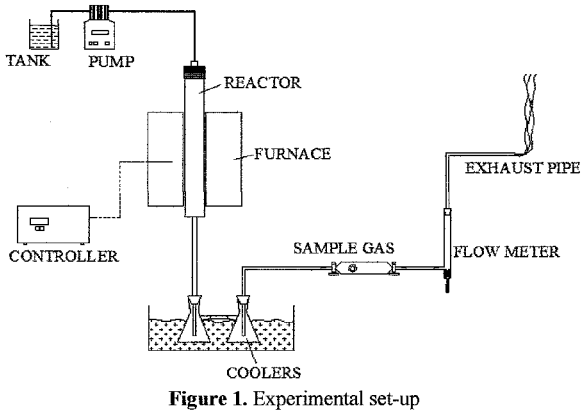

Figure 1. Experimental set-up

It consists basically on a stainless steel tubular reactor (inner diameter of 3.5 cm and length of 70 cm) where the glycerine gasification processes with steam takes place. A peristaltic bomb introduces the adequate glycerine/water ratio directly into the reactor. The gas produced is then passed through a quenching system (glass recipients covered by ice), where the condensable liquids are collected. Once the steady regime has been