

Problems Recorded on the Appropriateness of a Pilot Plant for Production of Second Generation Biofuels by Fast Pyrolysis

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The use of biomass as an energy source has proven to be a promising option as a means of reducing dependence on oil and mitigate climate change. The fuels produced from biomass are classified as first and second generation. The first-generation biofuels are produced mainly from sugar, starch and vegetable oil using conventional technologies, and in this segment, the most important ethanol and biodiesel. Ethanol is produced from biomass such as sugarcane, beet sugar and starch crops (maize and wheat). The second-generation biofuels are produced from lignocellulosic biomass mainly consisting of agricultural waste, forestry and industrial. In order to study routes for the processing of lignocellulosic biomass was performed a survey of the main technological routes, opting for tailor a pilot unit, already available for evaluation of reaction conditions via fast pyrolysis. The aim of this paper is to present the main problems identified in the operational suitability of a pilot unit of Fluid Catalytic Cracking (FCC), from the Research Center of Petrobras and its alternatives taken to resolve them. The test conditions were based on data identified in literature, namely, temperature: 450 - 550 °C, residence time: 0.5 to 5 heating rate is high. The tests show the viability of adapting an FCC unit to accomplish the fast pyrolysis process. Currently, the unit is being used to test new catalysts to obtain second-generation biofuels.

1 Introduction

According to the report "International Energy Outlook" of the 2009 Energy Information Administration (EIA), among the available energy resources, consumption of renewable energy is the fastest growing in the world at a rate of 3% per annum (Aperger and Payne, 2010) representing 14% of all energy consumed in the world (Zhang et al., 2010). The biomass used in biofuel generation allows the CO₂ generated by burning is recycled through its absorption by the photosynthesis process to grow a new plant biomass (Mohan et al., 2006 and Zhang et al., 2010; Aperger and Payne, 2010).

The fuels produced from biomass are classified as first and second generation. Most important, the first generation, are ethanol and biodiesel. Ethanol is produced from

biomass such as sugarcane, beet sugar and starch crops (maize and wheat). Biodiesel is produced from vegetable oils through transesterification process (Cherubini, 2010). According to balance the International Energy Agency, 2010, world production of first generation biofuels to 82 billion liters in 2008, with 28 billion liters (34%) were produced by Brazil, the second largest producer in the world, behind only the United States. Brazil has pioneered the use of ethanol as a fuel on a large scale between 1975 and 1986. Currently, all gasoline sold in the country is blended with ethanol in proportions ranging from 20 to 25%.

The second-generation biofuels are produced from lignocellulosic biomass mainly consisting of agricultural waste, forestry and industrial. Investments in the development of processes for production of second generation biofuels, have grown considerably in recent years, mainly because of the raw material is cheap and plentiful and not compete with food production, so these factors are advantageous in relation to first generation fuels. The potential energy derived from biomass waste worldwide is estimated at 30 million GJ / year, while energy demand is around 400 million GJ / year (Mckendry, 2002).

The fast pyrolysis seems more promising, among the processes of developing biomass conversion. Among the technologies identified the fast pyrolysis reactor, circulating fluidized bed has proved very attractive in terms of process. The continuously burning coal and coke produced in this reaction, a characteristic of this type of reactor, has a significant advantage over other technologies. Commercially, a similar technology is used for production of LPG and gasoline at oil refineries, called the Fluidized Catalytic Cracking (FCC).

2 Experimental Method

2.1 The pilot plant to study the fast pyrolysis process

2.1.1 General considerations

The process that uses circulating fluidized bed reactor is most recommended by the literature search was undertaken. Buoyed this survey we chose to adapt a fluid catalytic cracking pilot unit exists (Figure 1) to study the processability of sugar cane bagasse as filler and silica as bed stock. The selected drive has a processing capacity of 1000 g / h of liquid fed. In this unit, the catalyst is all loaded in the regenerator. The load is fed to crack at the base of the riser. The flow of catalyst is controlled by screw conveyors and flow between the vessels is done by injecting nitrogen in transfer lines. The regenerator and rectifier operate under fluidized by injecting nitrogen or steam. The cracking reactions occurring in the riser at a temperature of 700 ° C. The vaporized reaction mixture and the catalyst are separated in the stripper. The catalyst is rectified in the bottom of the vessel by injection of water vapor or nitrogen returned to the regenerator. The regenerator has the function of burning coke that has been generated on the catalyst surface, restoring its catalytic activity. The released product is directed to the cooling tower for condensing.

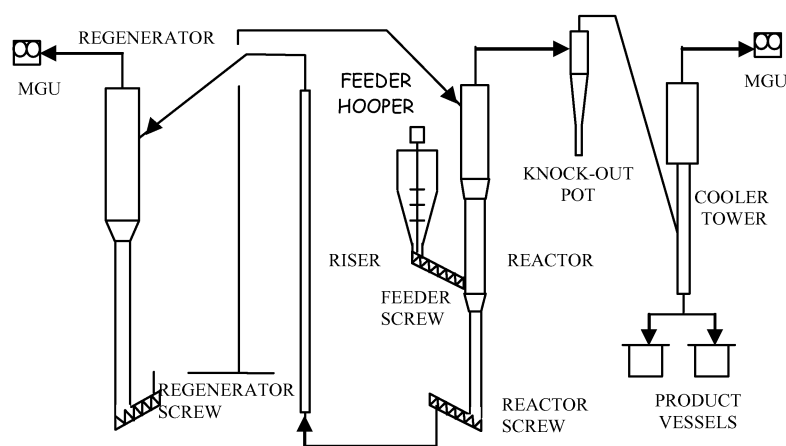


Figure 2. Schematic flowchart of the reaction unit in fluidized bed.

2.1.3 Tests of conditioning Unit

Tests of conditioning, aimed to evaluate the system load of biomass in the reactor and the effects of high temperatures, the flow of biomass and type of catalyst. The test conditions were based on data identified in literature, namely, temperature: 450 - 550 ° C. The parameters were monitoring the process, the gas flow generated, the feed rate of biomass and the overall efficiency of the process..

2.1.3.1 Gas flow generated in the process

In tests of conditioning were observed instabilities in some variables in the process, among them the flow of product gas unit, indicating a possible discontinuous feeding of biomass in the reactor, as shown in Table 1.

Table 1: Variation of the gas flow generated in fitness race

Run	Gas flow reactor (l/h)	Standard deviation	RSD (%)
1	666,91	69,11	10,36
3	655,54	188,96	28,83
3	500,07	92,06	18,41
4	441,96	59,65	13,50
5	957,59	133,67	13,96

Peak flows of biomass resulted in excessive formation of coke and coal in the reactor, and consequently the overhead of the regenerator. Due to the inefficient burning of the catalyst, clogging lines occurred and tests were stopped prematurely.

2.1.3.2 Overall yield

In the case of a pyrolysis unit, three chains make up the mass balance: liquid (bio-oil), gas and solid (coke and coal). The mass of liquid is obtained by weighing the effluent. The amount of gas generated is measured using a wet gas meter (MGU). The current

sound is measured by counting the mass of carbon gas regeneration. As shown in Figure 3, it was observed that increasing the flow of cargo generated losses in overall yield, indicating the need to limit the flow to values between 500 and 700 g / h, obtaining thus income in the range between 80 and 90%.

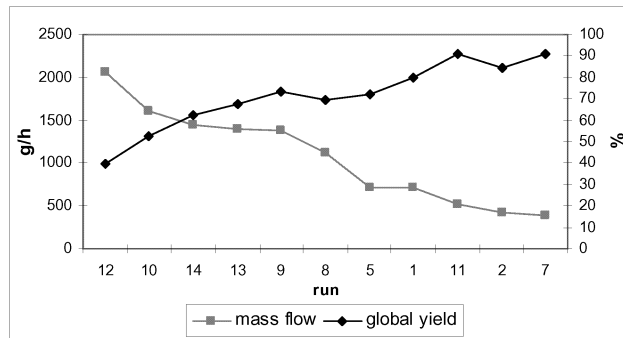


Figure 3. Behavior of total income due to the variation of the flow of biomass

2.1.3.3 Biomass Power System

As shown in Figure 4, during the conditioning tests, it was found that even by fixing the feed screw rotation, the system indicated a wide variation in the mass loaded flow.

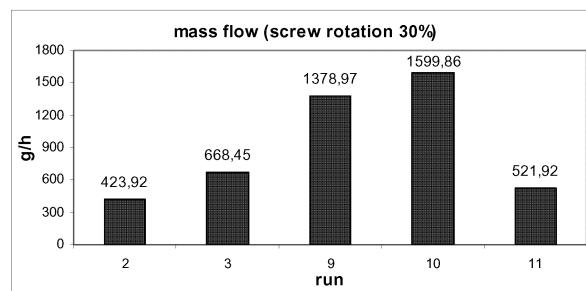


Figure 4. Behavior of the feed flow in the process of biomass

3 Results and Discussion

With the data obtained in tests of conditioning, adjustments were made in the plant that made possible the races varying load flow, reaction temperature and type of catalyst. In Figures 5 and 6, we observe that the plant operated stably indicating only small variations in gas flow, a product generated in the process.

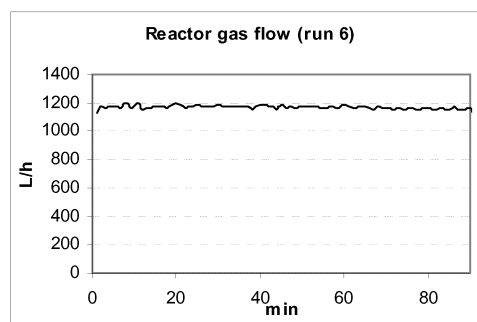


Figure 5. Gas flow in the reactor

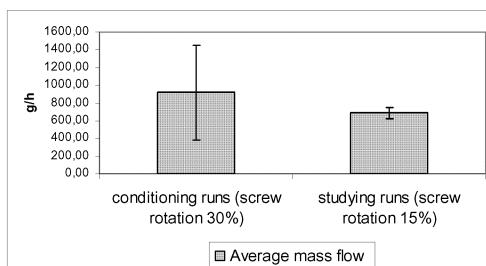


Figure 6. Flow behavior of biomass in the reactor

Currently, the plant has been used for the study of new catalysts to improve both the yield on the amount of bio-oil obtained as its quality.

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