Used frying oil for biodiesel production: the case of a processing company in the state of Sao Paulo, Brazil

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Abstract

Biodiesel has emerged in Brazil as a renewable and inexhaustible source of energy, which allows: a) reduce the use of foreign exchange by importing oil and diesel oil, b) reduce environmental pollution and c) generate positive impacts on environments that provide raw materials for their production. For the production of biodiesel are used inputs and raw materials of vegetable, animal, as well as various types of waste. In this context, is object of attention of this article the use of used frying oil as raw material available from the urban residue, which can be transformed into high quality biodiesel. Biodiesel production, from waste oils in frying food, enables reuse and reduce the volume of waste to 88%, being 2% solids, 10% glycerol, and 88% ester with energy value. The field research that gave support to this article was carried out at a vegetable oil refinery, located in the State of Sao Paulo, Brazil, belonging to the main supplier of biodiesel to Petrobras. The company uses various types of raw materials and inputs, among which used frying oils. The reverse logistics made by the company contributes to the preservation of the environment, creates new products and adds value to the productive chain, through a useless residue already considered disposable. The biodiesel produced from used frying oil can be used in its pure form or mixed with diesel oil (fossil fuel) without limitation of proportion.

Keywords: biodiesel, used frying oil, reverse logistics, urban residue.

1 Introduction

With the growing worldwide demand for renewable fuels and least harmful to the environment, biodiesel has emerged in Brazil as a renewable and inexhaustible source of energy, which allows: a) reduce the use of foreign exchange by importing oil and diesel oil, b) reduce environmental pollution and c) generate positive impacts on environments that provide raw materials for their production.

For the production of biodiesel are used several inputs and raw materials of vegetable or animal origin, as well as various types of residues. Among the inputs of vegetable origin are the oils of palm, palm kernel, canola, wild radish, soybean, among others. Amid the inputs of animal origin are the tallow from cattle, pigs and poultry. Among the residues are used frying oil.

The following figure shows the share of raw materials in production of diesel oil.

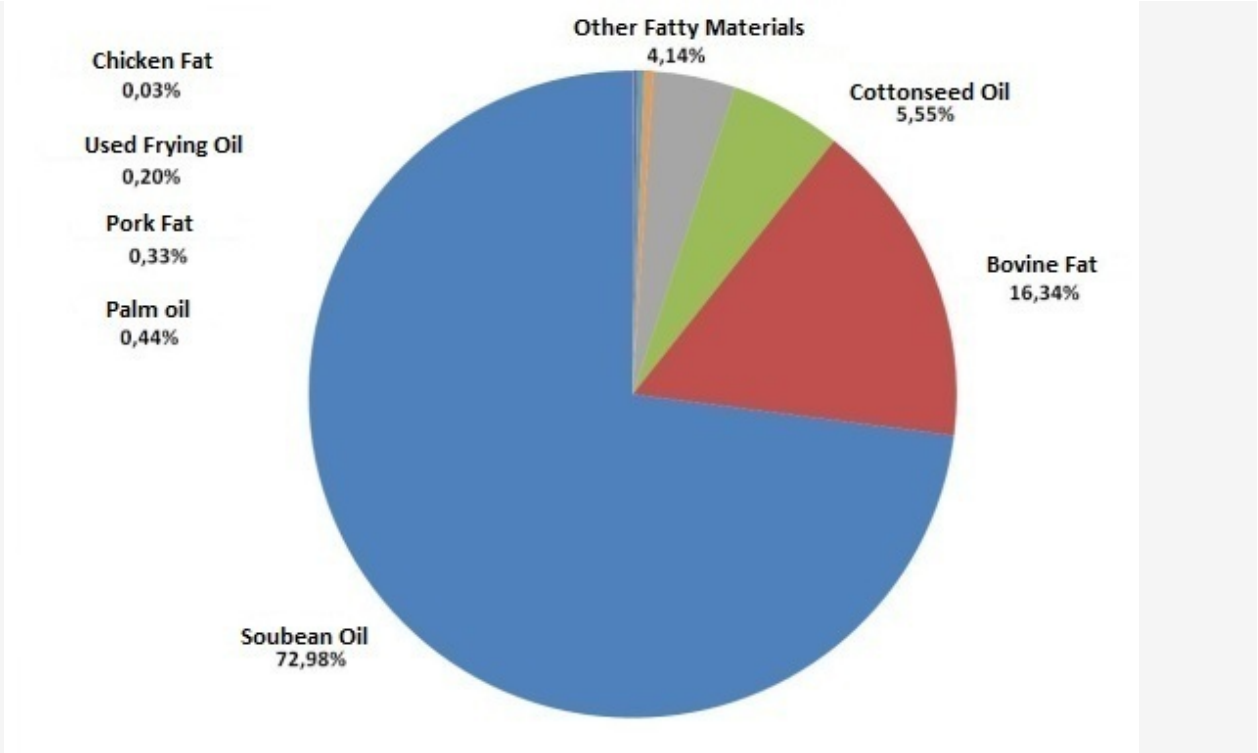

Figure 1: Raw materials used for production of biodiesel. Source: ANP (2011)

The production of Biodiesel from used cooking oil allows reuse and reduction by 88% the volume of residues, 2% solids, 10% glycerol and 88% ester with energy value (Quercus, 2002 apud Castellanelli 2008). Therefore, despite the low participation of this raw material in the production of biodiesel, in Brazil is great the environmental significance of such use.

Therefore, it is object of attention of this article the use of used frying oils (UFO), raw material available from the urban residue, which can be transformed into high quality biodiesel.

These oils are consumed widely, for the preparation of food, both in homes as in industrial and commercial production.

Once used, they are generally released in natura, without proper treatment, causing serious damage to the environment and human health. (Reis et al, 2007 apud Santana et al, 2010).

Therefore, its use for the production of biodiesel contributes to reduce the environmental impact deriving from the generation of residues from the food preparation.

In this context, the present paper, without ignoring the immediate benefits of using biodiesel on the environment, has for main objective to characterize the positive effectiveness of production of that fuel from used frying oils, contributing in this way, with the absorption of this urban residue .

It is worth remembering that the demand for biodiesel in Brazil has increased after 2008, with the mandatory blending of biodiesel with diesel oil. Starting with 2% (B2) in January 2008, rising to 3% plus (B3) in 2009 and 5% (B5) in 2010, in accordance with Resolution CNPE (National Energy Policy Council) number 6 of 16/09/2009, which is in effect today. (CNPE, 2009)

The ANP, in monthly bulletin of December 2011, reports that there are 65 biodiesel plants licensed to operate in the country, accounting for a total authorized capacity of 18,727.95 m3/day.

Of these 65 plants, 60 are authorized for commercialization of biodiesel produced, corresponding to 17,150.25 m3/day of capacity authorized for marketing (ANP, 2011).

The Monthly Bulletin of Biodiesel, dated December 2011, published by the ANP, records the existence of eight plants producing biodiesel in the state of São Paulo, with total production capacity installed 2678.65 m3 / day of product (ANP, 2011).

Despite the numerous sources of raw materials, many of these plants work with excess capacity, well above planned levels. The use is only 41% of the productive potential (Lessa, 2011). Thus, existing plants have capacity for use of frying oils used as raw material.

Table 1: Processing plants authorized in the State of Sao Paulo

			Autorized cap	**Authorizations existing**	
Enterprises	**City**	**CNPJ National Regi Juridical Persons**	**(m^3/day)**	**For Operate**	**For Commercialization**
BIO PETRO	Araraquara	07.156.116/0001-63	194,44	N° 57, de 03/02/2 de 07/02/11	Nº 68, de 10/02/201 11/02/11
BIOCAPITAL	Charqueada	07.814.533/0001-56	824,00	Nº 395 de 01/11/. de 05/11/07	Nº 13, de 12/01/2009 13/01/09
BIOVERDE	Taubaté	04.182.260/0001-86	503,27	Nº 712 de 15/12/. de 16/12/10	Nº 39, de 28/01/2011 31/01/11
FERTIBOM	Catanduva	00.191.202/0001-68	333,33	Nº 557 de 10/09/. de 13/09/10	Nº645, de 25/10/2010 26/10/10
INNOVATTI	Mairinque	06.096.144/0001-70	30,00	Nº 196 de 01/08/. de 02/08/07	Nº567, de 11/11/2009 12/11/09
JBS	Lins	02.916.265/0133-00	560,33	Nº 16 de 12/01/2 de 14/01/10	Nº55, de 02/02/2010 DOU de 03/0
ORLÂNDIA	Orlândia	53.309.845/0001-20	150,00	Nº 369 de 11/08/. de 12/08/11	Nº378 de 17/08/2011 18/08/11
SP BIO	Sumaré	05.164.528/0001-10	83,28	Nº 560 de 09/11/. de 10/11/09	Nº572 de 11/11/2009 12/11/09
Total			**2.678,65**		

Source: ANP, 2011

1.1 Use and recycling of used frying oil (UFO)

In Brazil and in Rest of World the use of vegetable oils for food preparation has expanded widely in industrial complexes, private homes and in restaurants and the like.

The justifications for using oil in cooking are numerous. Frying is a preparation operation fast and food fried give unique characteristics of satiety, aroma, flavor and palatability (Reis et al, 2007).

The increased use of cooking oil, often used in frying, can result in damage to the environment if disposed of down the drain of the sink, because it causes clogging of the pipes in the sewers, increasing by 45% the costs of treatment (Rabelo ; Ferreira, 2008).

Thus, the incorrect disposal of frying oils by households and businesses has several problems to the environment and, specifically, to the sewer lines. In course of time, are generated significant costs to society in general and increasing concern about the environment.

Therefore, recycling the cooking oil helps to prevent the pollution of air, minimizing also the possibility of future health problems.

The recycling of waste frying has been highlighted by the production of fatty acid esters, biofuels. Recall that the esters of fatty acids do not contribute to the formation of "smog" photochemical therefore not present in their structures neither sulfur neither nitrogen. Therefore, do not contribute to the phenomena of acidification of precipitation (Castellaneli, et al, 2007).

Currently the result of recycling of residue vegetable oils saturated is intended for use as an ingredient of the biodiesel, a technique used to produce soap, resins for paints and glazing putty (Baldasso et al, 2010).

According Castellanelli et al (2007), the correct destination of kitchen residues, in this case, the used frying oil, avoids the risk of environmental pollution.

Disposal of used frying oils in sinks and toilets, or directly into the sewerage system, can cause various environmental problems, can generate malfunctioning sewage plants and result in waste of a possible energy source.

For the processing of residual frying oil is needed a logistics structure for the collection of such material, under the coordination of biodiesel processing company.

This processing company also operates in the refining of vegetable oils using the tool reverse logistics to collect the material, in supermarkets, municipal governments, assistance entities and exchange stations. The adoption of the reverse cycle of the product can prevent and / or minimize environmental degradation, bringing therefore a competitive advantage for companies (Santana et al, 2010).

1.2 Methodology

This article was developed from specialized literature and results of a case study conducted in a plant for refining vegetable oils, in the State of Sao Paulo, Brazil, belonging to the main supplier of biodiesel to Petrobras.

This company produces vegetable oils, in their natural state or refined, soybean meal or pellets, biodiesel, glycerin, lecithin, and related products. Are used various types of raw materials and inputs, among which used frying oils. It is also a major supplier to Petrobras, in the capture of frying oils used in order to reduce the environmental impacts of waste. For the transesterification process, it is possible to generate a new product from what was formerly considered garbage.

This is an applied research, generating knowledge for practical application.

2 The National Program for Biodiesel Production and recycling of waste frying

The National Program of Biodiesel Production (PNPB) was created by Law No. 11,097 of January 13, 2005 and has been seeking new alternatives for the production of biodiesel. Among them is the utilization of used frying oil (UFO).

Thus, it contributes to the used oil not be disposed off in sinks and drains in toilets to avoid clogging the sewage galleries. According to Girard (2010), when the oil goes into the gallery of sewage works as a glue, adding all the discarded material, forming a mass that ends up clogging the sewer system that receives this material.

Recently, companies refining of vegetable oils, which are focused on the production of refined oil for human consumption, are dedicated also to the manufacture of biodiesel.

This occurred with the company investigated, promoting and enabling the idea of environmental preservation and social responsibility in the face of domestic and industrial residues from the preparation of meals and food in general, passing through the frying process.

Among the actions carried out by the company stands out maintenance of agreements with supermarkets and restaurants for the exchange of used oil by new soybean oil, refined .

2.1 The logistics of collection and exchange of used oil with new oil for human consumption.

The logistics of collection of used oil is monitored by sales team of refined oil bottled by agreements and contracts signed with customers and partners such as ONG's (Non Governmental Organizations) and municipalities.

In these agreements signed, the manufacturer of vegetable oils is responsible for collecting the used frying oil, where are the customers or partners.

The collection is made when the used oil stored by customers or partners reaches 200 kg. Reached this amount, the collection is carried out and the collected material is transported to the plant for proper storage and further processing.

For Pitta Jr. et al (2009), it is recommended that the conditioning is made in the oil containers with a capacity of 500 ml to 2 liters in the case of dwellings, and from 20 to 50 liters in commercial locations.

In the company investigated,the return of UFO must be done in two 2-liter PET bottles each, clear color, which facilitates visualization of the product and the count at the time of exchange, avoiding the operation of weighing of filled containers and then empty, which make the process laborious , burdening the cost of operation.

The packagings (PET) after empty are sent to a recycler of plastics materials, adding value back to a product that has a great impact on nature, the environment and the cities. When this packaging is discarded improperly, by the inhabitants, causes clogging of drains stormwater runoff, causing flooding.

Made the collection of used oil, this remains in the processing unit, in appropriate tanks, to be sent to the processes of filtration, neutralization and transesterification. Thus is avoided the environmental contamination and the infiltration of waste into groundwater. The biodiesel is a new product resulting from this process.

Pitta Jr. et al (2009), consider that the return of cooking oil to the productive chain as raw material adds economic value to the process, commends the company's name to the consuming public, reduces the cost of the product, serves to manufacture of new products such as biodiesel, paints, gear oils, soap and detergents, contributing also to the preservation of the environment

When the residues are transported to the plant of refining oils and are processed in it, is carried out reverse logistics.

The reverse logistics made by the company, helps to preserve the environment and generate new products, adding value to the productive chain, by a product which no longer considered useful. To Lacerda (2002 apud Pitta, Jr. et al 2009), Reverse Logistics can be defined as the process of planning, implementing and controlling the flow of raw materials, stock in process and finished goods (and its information flow) of point of consumption to the point of origin, with the goal of recapturing value or perform a proper disposal.

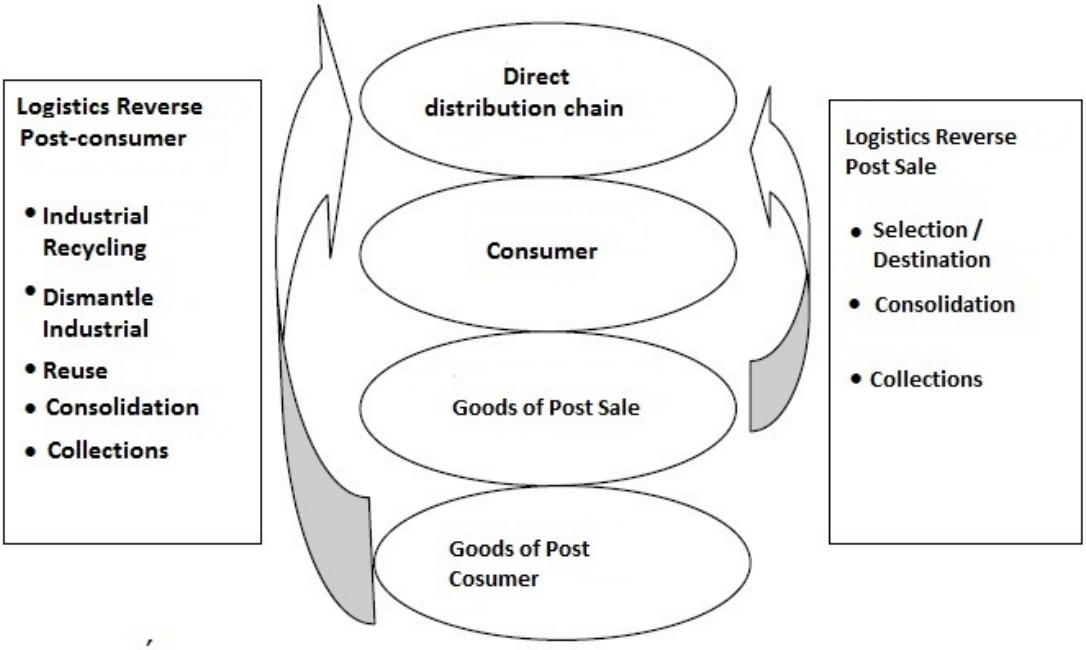

Figure 2: Area of operation and reverse stages. Sourse: Leite (2003 apud Pitta, Jr. et al 2009)

2.2 The process of transesterification

Transesterification is nothing more than the separation of glycerol vegetable oil. About 20% of a vegetable oil molecule consists of glycerin. First, as shown in figure 2, the oleaginous seed is subjected to pressing, from where the products are extracted: crude oil and pie (bran).

For the production of biodiesel is necessary to add ethanol to the crude oil already neutralized occurring, so the transesterification. The glycerin makes the oil more dense and viscous. During the transesterification, the glycerin is removed from the vegetable oil leaving thinner the oil and reducing the viscosity (Biodieselbr, 2010).

In the case of used frying oil (UFO), the process begins by neutralization. The acidity is removed from the oil and filtering enters for the transesterification, as shown in Figure 3.

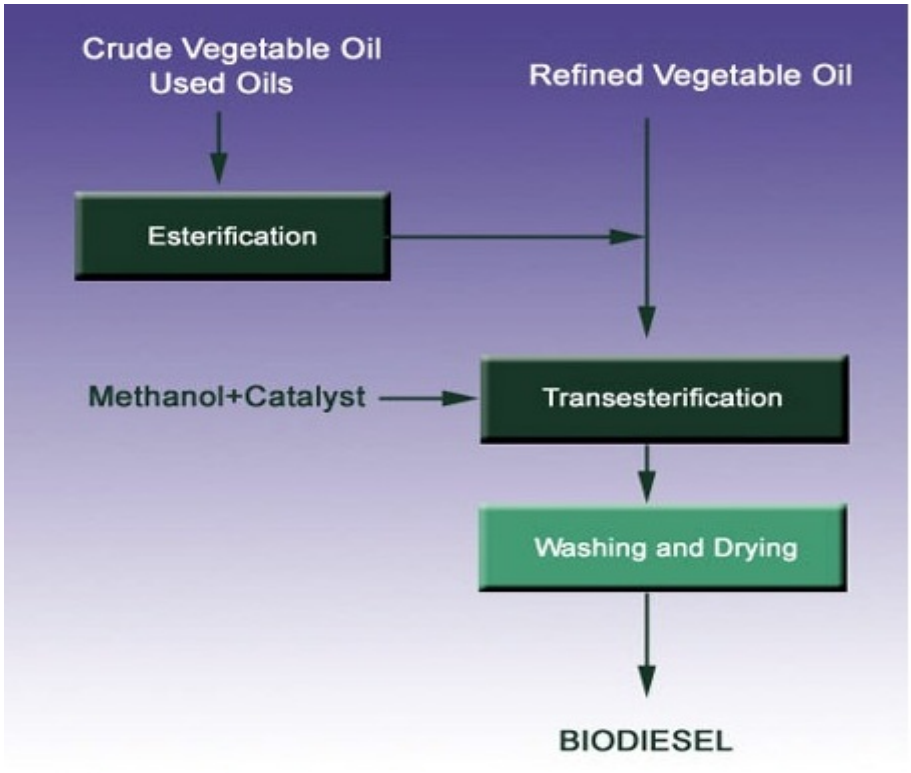

Figure 3: Process for producing biodiesel. Source: Rimlife, Jan. 2012

In Figure 4, presented below is a description of the cycle the residual oil (Rabelo, 2002)

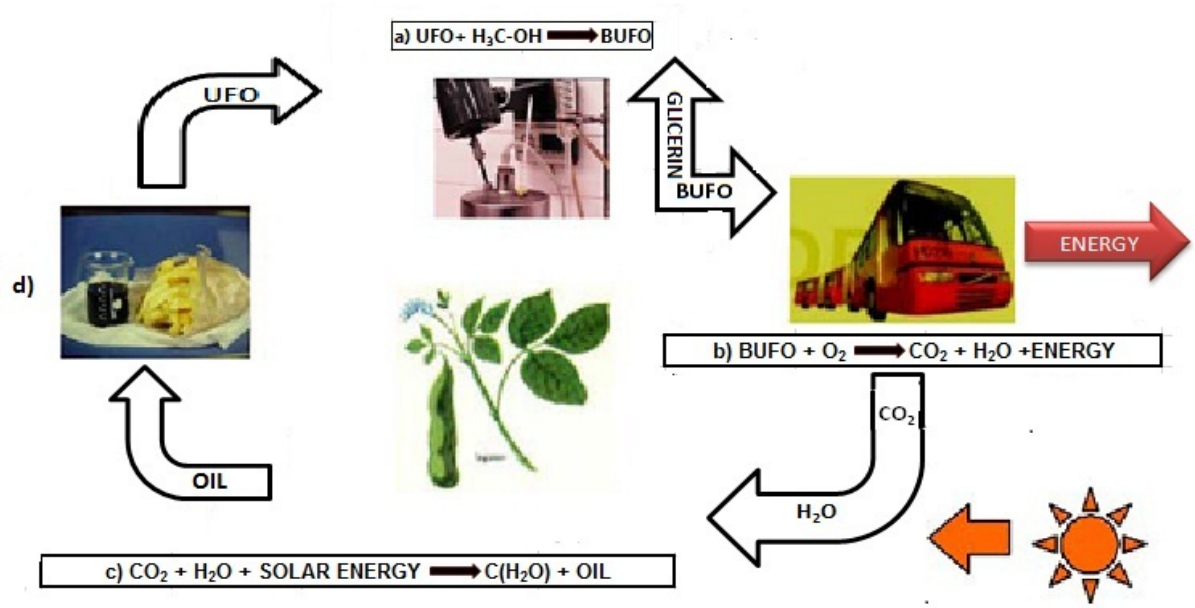

Figure 4: Cycle oil used in frying. Source: Rabelo, Ivan. et al (2002. p. 2).

a) The transesterification reaction with methanol using as raw material UFO gives as the main product the BOUF and the glycerin as byproduct . BOUF is used in internal combustion engines.

b) In burning, the engine consumes oxygen and releases carbon dioxide as water and energy.

c) The oil plants use carbon dioxide, water and solar energy to produce carbohydrates and oil.

d) The oil is extracted and used as a means of heat transfer for cooking different foods. Its quality is lost with time and use instead of being discarded into the environment, serves as a raw material for the transesterification reaction, thus closing the cycle.

The chemical reaction produces esters of substances resulting from the reaction between methanol and fatty acids, thus producing biodiesel.

According to Almeida (2005), esters are substances resulting from the reaction of a carboxylic acid with an alcohol. Methyl esters of fatty acids derived from reactions of methanol and fatty acids. The fatty acid methyl esters (biodiesel) are produced from substances contained in vegetable oils such as mustard oil, sunflower and soybean.

Christoff (2007) developed a study in the city of Guaratuba-PR, Brazil, by volume of residual oil for frying provided by 28 merchants. From that biodiesel production, in laboratory scale, the researcher estimated the amount of biodiesel produced and the amount of catalyst and ethanol required. The survey distinguished between periods of high and low season, with different results due to the volume of oil collected. Was also found to variation according to the catalyst used in the production process. The results are shown in Table 2.

Table 2: Estimated amount of biodiesel produced in pilot scale in Guaratuba-PR, from frying oil residual (Donated by 28 commercial establishments)

Season	Residual oil available frying (l/mounth)	Volume alcohol required (l/mounth)	Amount of catalist (l/mounth)	Amount biodisel (l/mounth)
low	2.400	1.770	14	2.040
high	5.700	4.230	33	4.845
Total annual	42.000	31.800	244	35.700

Source: Christoff (2007, p. 47)

Menezes et al discuss about the advantages and disadvantages of the production of biodiesel made from residuals frying oils. According to the authors, there are both advantages and disadvantages in the production of biodiesel made from oilseeds such as from the use of residuals frying oils.

Therefore, other variables must be analyzed, such as the costs involved and the supply of raw materials. Considering that this is the production of vegetables, should be considered the alternative land uses.

SABESP (Basic Sanitation Company of São Paulo - BR), based on data collected from the ABIOVE (Brazilian Association of Vegetable Oil Industries) on volume of production of vegetable oil (as of December 2009) and their destinations , inferred that annual market of recycled frying oil is in the order of 30 million liters or 24,000 tonnes. This amount includes both collection to the industrial process, such as recycling in the manufacture of homemade soap, made by the informal market. According to information from the company, with 1 liter of the frying oil can be produced approximately 0.95 liters of biodiesel (PRO, n/d).

Therefore, consideration should be given that the use the cooking oil means not dispute the agricultural area with the areas used for food production. It should also be considering that on the one hand, is greatly reduced the cost of raw materials and, moreover, the benefits that their use can bring to the environment are large.

According to information SABESP, to ensure mixing B5 (5% biodiesel in diesel fuel) are needed 2.6 million cubic meters of biodiesel. It should be remembered that there are over 200 plants in the design, in construction and planned in Brazil, and 65 are already in operation.

Thus, the use of used frying oil presents to be opportune considering environmental and opportunity costs.

3 Conclusion

Biodiesel derived from the UFO (used frying oil) can be used in its pure form or mixed with diesel oil (fossil fuel) without limitation of proportion.

So it is avoided that the cooking oil will be disposed off in sinks and drains rainwater into pipes, allowing a greater conservation of the sewage system, the nature of the sources of drinking water, contributing to the maintenance of conditions favorable for human life on the planet.

Biodiesel has a positive feature, because of its low toxicity and poisoning, which does not occur with fossil fuels. This product is among the most promising, as ethanol.

The reduction of pollutant emission enables the reuse of waste frying of households and businesses that need to use food frying in its production process.

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