Biodiesel production from bovine tallow

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Abstract: Biodiesel is produced from vegetable oils, animal fats and waste oils and fats. This is a newer experience, because in 2004 the National Program for Production and Use of Biodiesel (NPPB) was created by the Ministry of Agrarian Development (MDA), but released only in 2005. This study was a micro-scale plant to process beef tallow into biodiesel, to add value to these products. It also aims to bring a gain in environmental quality for the region, as a social and environmental program to collect and saturated fat frying in oil and neighborhood associations within the school community, restaurants and hotels will be implemented. This oil is also processed into biodiesel, which will be used by the fleet of the refrigerator itself, in Santa Vitoria do Palmar, pretty or totally reducing the consumption of diesel derived from petroleum. The study of unit operations and layout for equipment sizing was performed. The economic and financial analysis was also performed to establish whether the deployment feasibility of this micro-distillery. As the economic analysis, it was observed that it is not feasible the implementation of micro-plant if the need to hire an employee to work on it only because it will increase their spending for the production of biodiesel, compared to what is spent on fuel today. Came to the conclusion that if the refrigerator to continue with the same number of existing employees, and to designate a micro-distillery only in days of production, the project becomes interesting, as there will be a salary to be paid more. Taking into account that increase the consumption of meat, or that the campaigns to collect waste oils and fats have a great impact in the municipalities, thereby doubling the batch production, even hiring an employee, the project becomes viable Excess biofuel produced which can be used in generators to reduce the amount spent on electricity. The use of tallow for biodiesel production in this refrigerator is an alternative to reduce the cost of fossil fuels and also to add value to a by-product, since it shows good yield for biofuel processing. The socio-environmental appeal that this micro-power plant will bring to the region is also important, since the whole community will benefit from the action of collecting waste oils, relieving the environment of this type of pollution.

Keywords: biodiesel, tallow

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1 Introduction

Renewable sources of energy is any type of energy originated from a natural source such as water (hydropower), sun (solar energy), wind (wind power), the wave motion (wave energy), geothermal and biomass energy, in which biofuels are included (COSTA, 2012; GARCIA, 2012).

In Brazil, the production and use of biofuels began in the 70's with the oil crisis. So Pro-Álcool was created (Federal Decree 76.593 - November 14, 1975), making the country to become one of the largest producers and consumers of biofuels in the world. Pro-Álcool program aimed to use an alternative fuel to replace fossil fuels. Since then, there has been a great improvement of biofuels in Brazil (ANP, 2012).

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Biodiesel is produced from vegetable oils, animal fats, and waste oils and fats. This is a newer experience, because in 2004 the National Program for Production and Use of Biodiesel (PNPB) was created by the Ministry of Agrarian Development (MDA/Brazil), but released only in 2005.

In 2012 2.72 billion liters of biodiesel were consumed in Brazil, which represents an increase of 6.9% compared to 2011. As there was no change in the mandatory content of 5% to be added to the diesel fuel, consumption growth was exclusively due to the increase in domestic demand for diesel, totally independent of variation of 0.9% of GDP. With these numbers, Brazil is now the third largest biodiesel producer in the world, behind only the United States and Argentina, surpassing Germany, which was once the largest producer and consumer. Since 2005, year of the National Program for Production and Use of Biodiesel beginning, until December 2012, 11 billion liters of the biofuel have already been produced and consumed in the country (EPE, 2013; MARTINS et al., 2011). Today, virtually all tallow produced in the country is used in biodiesel production (ODI/PR Energy, 2012).

This study was a micro-scale power plant attached to a slaughterhouse to render cattle tallow, which is now disposed to feed other industries, biodiesel, and adding value to these products. It also aims to bring a gain in environmental quality in the region, as a social and environmental program by collecting saturated fat frying oil in the neighborhood associations, schools, restaurants, and hotels. This oil will be also processed into biodiesel, which will be used by the fleet of the slaughterhouse itself, in Santa Vitoria do Palmar/RS, partial or totally reducing the consumption of petroleum diesel in the company.

2 Material and methods

The study of unit operations and layout for equipment sizing was performed. Practical experiments on a small scale using tallow of the slaughterhouse itself and the details of the processes were calculated from data of Lopes (2006); Krause (2008); EMBRAPA (2011); IPEF (2012).

The withdrawal of the animal tallow occurs in the slaughterhouse. This tallow will be stored in boxes with a capacity of approximately 38 kg in a cold chamber until the amount to do a batch of biodiesel (1.500 kg) was achieved.

Data on the monthly collection of frying oils and saturated fats were calculated taking into account studies from IBGE (2010) and AFUBRA (2013), in three counties, which were used to estimate the amount in Santa Vitória do Palmar and Chuí deliveries. Whereas, the studies showed that 0.1 liters per capita per month of frying oil was used.

Collection of frying oil will be done with the slaughterhouse own vehicles. This material will be obtained from social and environmental programs made in the schools, community centers, restaurants, and hotels of the city and in the neighbor county, Chuí, with the help of posters and lectures.

The economical and financial analysis was also performed to establish whether there will be deployment feasibility of this micro plant, through three scenarios: Scenario 1: four production batches per month will be made with one worker hired; Scenario 2: four production batches per month will be made without a worker hired; Scenario 3: six production batches per month with one worker hired. The studied indexes were: IRR (Internal Rate of Return); IRRm (modified TIR); MRA (Minimum Rate Attractiveness) and payback, which are the time to return the invested capital in the project in 10 years planning, according to Buarque (1991).

3 Results and discussion

The unit operations studied to compose the process flowchart (Figure 1) are: receiving the batch of 150 kg of fat stored in a cold chamber, and depositing on a stainless steel tank heated with steam jacket, which will start the production process. After the material is melted at a

temperature above 45 ℃, and sieved to retain remains not melted, the liquid moves to the second tank at 70 ℃, where it is screened in a smaller mesh than the first screen. Then, the oil is sent to the reactor by a pump. This reactor is equipped with a stirrer and a resistance to keep the heated liquid in movement. To perform the trans-esterification reaction, CH_3OH (alcohol) and NaOH (caustic soda) are added to the mixture by another pump, according to Meneghetti et al. (2013). The mixture is allowed to precipitate for one day and glycerin is removed by gravity from the bottom of the reactor, leaving only the ester.

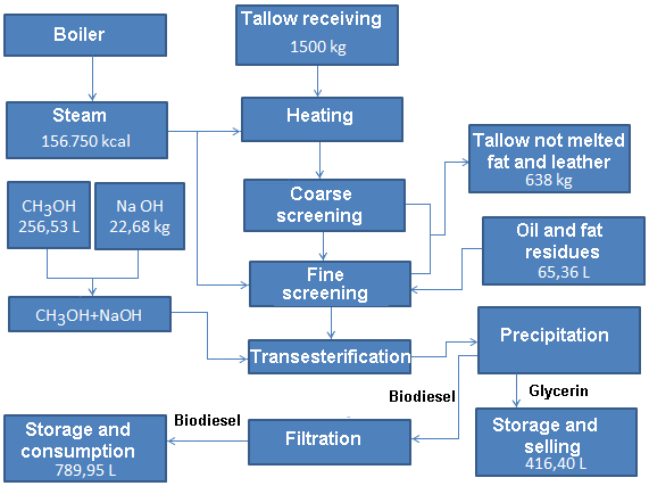

Figure 1 Flowchart and mass balance of biodiesel production from tallow in batches

Alcohol and caustic soda will be stored at a distance from micro plant in a shelter with fireproof walls and will only be taken to the site in time to be used. The glycerin will be stored in drums in the warehouse until being shipped. The biodiesel will be removed by a pump and passed through a filter with activated charcoal, eliminating the need of washing, and will go straight into a trailer tank. This trailer tank will transport the biodiesel 50 m away from the site of micro-plant, where it can be blended with petroleum-based diesel for consumption of the fleet.

The collecting waste oils and fats in the counties of Santa Vitória do Palmar and Chuí were estimated at 261.44 L/m.

The monthly consumption of diesel until October 2013 in vehicles of the slaughterhouse was 3,544 L/m. Thus, total production, using tallow and collected oil will be 2,785.12 L/m of biodiesel, which represent 78.86% of the average consumption of the fleet.

As the economic analysis, it was observed that Scenario 1 is not feasible for deployment of micro-distillery by requiring the hiring of an employee only to work on it. In Scenario 1 the price of biodiesel would be R$ 2.51 (US$ 1,00 ≈ R$ 2.224), not being attractive to the entrepreneur, because it is not possible to obtain a higher IRR than the MRA in this case. However, in Scenario 2, if the slaughterhouse designates one of its employees for the micro-distillery only in days of production, the project becomes viable with IRRm (19%) higher than the MRA, which is 10.69% per year, and with return on invested capital (payback) in three years.

Taking into account that the consumption of meat could increase, or that the campaigns to collect waste oils and fats could have a big impact on municipalities, reaching six batches production each month, even hiring an employee (Scenario 3), the project becomes viable with an IRRm (20.43%) than MRA, and a payback of five years. Excess biodiesel produced can be used in generators to reduce the amount spent on electricity in the plant.

4 Conclusion

The use of tallow for biodiesel production in this slaughterhouse is an alternative to reduce the cost of fossil fuels and to add value to this sub-product.

The socio-environmental appeal of this micro plant is important because it will benefit the community by the action of collecting waste oils, relieving the environment of this type of pollution.

The project becomes viable with six monthly batches, which would exceed the amount of fuel needed by the slaughter-house fleet.

The alternatives to using the surplus production would be to purchase generators to reduce the amount spent on electricity, since that Brazilian law does not allow the biofuel direct sale to consumers.

The scenario with four monthly production batches and one hired worker is economically unfeasible, but without hiring the employee, would be feasible.

References

AFUBRA. 2013. Associação dos fumicultores do Brasil. Cachoeira em segundo no ranking da Afubra. Jornal do Povo, Cachoeira do Sul, p.12, 22 mar. 2013.

ANP. 2012. *Agência Nacional de Petróleo, Gás Natural e Biocombustíveis. Biocombustíveis*. Available in: <http://www.anp.gov.br/?pg=60467&m=&t1=&t2=&t3=&t4= &ar=&ps=&cachebust=1383165990915>. Access in: 26 out. 2013.

BUARQUE, C. 1991. *Avaliação econômica de projetos: uma apresentação didática*. 6.ed. Rio de Janeiro: Campus.

COSTA, J.C.V. 2012. *Mercado de energias renováveis representa 47,3% da matriz energética brasileira*. Available in: http://www.upf.br/comarte/?p=605 . Access in: 21 out. 2013.

EMBRAPA. 2013. *Gordura animal*. Available in: <http://www.agencia.cnptia.embrapa.br/gestor/agroenergia/arvore/CONT000fj1om7kf02wyiv802hvm3jholyoom.html>. Access in: 31 out. 2013.

EPE. 2013. Empresa de pesquisa energética. Análise de conjuntura dos biocombustíveis. Available in: <http://www.epe.gov.br/Petroleo/Documents/An%C3%A1lise%20de%20Conjuntura%20dos%20Biocombust%C3%ADveis%20-%20boletins%20peri%C3%B3dicos/An%C3%A1lise%20de%20Conjuntura%20dos%20Biocombust%C3%ADveis%20%E2%80%93%20Ano%202012.pdf>. Access in: 02 nov. 2013.

GARCIA, Sebastião. 2012. *Sebo bovino é alternativa viável para a produção de biodiesel*. Available in: <http://pecuaria.ruralbr.com.br/noticia/2012/02/sebo-bovino-e-alternativa-viavel-para-producao-de-biodiesel-3670782.html>. Access in: 29 out. 2013.

IPEF. 2012. *Instituto de pesquisas e estudos florestais.* Available in: <http://www.ipef.br/geodatabase/repository/651da1d8va615cz1ad1da8s4rq8146a1dsa2132c1zn1/bra_1_tmed_ann.pdf> Access in: 11. Feb. 2014.

Krause, and Laíza Canielas. 2008. *Desenvolvimento do processo de produção de biodiesel de origem animal.* 147f. Thesis (Doctor in Chemistry) – UFRGS, Porto Alegre.

Lopes, and Elaine Martins. 2006. *Análise energética e da viabilidade técnica da produção de biodiesel a partir de sebo bovino*. 120f. Dissertation (Master in Energy Engineering) - UNIFEI, Itajubá.

Martins, Renata; Nachiluk, Kátia; Bueno, Carlos Roberto Ferreira; Freitas, Silene Maria de. 2011. O biodiesel de sebo bovino no Brasil. São Paulo, *Informações Econômicas*, 41(5): 6-70. Available in: <ftp://ftp.sp.gov.br/ftpiea/publicacoes/ie/2011/tec5-0511.pdf> . Access in: 26. Nov. 2014.

Meneghetti, Simoni P.; Meneghetti, Mario Roberto; Brito, Yariadner C. 2013. A reação de transesterificação, algumas aplicações e obtenção de biodiesel. *Rev. Virtual Quim.*, Universidade Federal Fluminense, 5(1): 63-73. Available in: < http://www.uff.br/RVQ/index.php/rvq/article/viewFile/389/296>. Access in: 26. nov. 2014

ODI/PR ENERGIA. 2012. *Praticamente 100% do sebo bovino produzido no Brasil é destinado à produção de biodiesel.* Available in: <http://rotaenergia.wordpress.com/2012/06/04/praticamente-100-do-sebo-bovino-produzido-no-brasil-e-destinado-a-producao-de-biodiesel/> Access in: 28 out. 2013.