Diesel-like fuel production from the waste grease of the biggest wastewater treatment plant of the capital of Brazil

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Introduction

Sanitation systems are regrettably still the destination of large amounts of waste fat (He, 2011), oils and grease (WFOG) used in food preparation in homes, restaurants and snack bars. This release is inappropriate and damaging to sewage treatment systems and the environment. This type of waste needs special attention, mainly because it pollutes in a discreet and continuous way (Rodriguez, 2012). One initiative to avoid oils and fats from being released into the effluent occurs in Brasilia, capital of Brazil. In 2010 a big initiative involving several public institutions was made with big waste oil generators to send their WFOG to the Sanitation Company (CAESB), for a fee. After separation of phases in a greasy separation chamber, the solid part would be sent to the Company responsible for garbage collection for the correct destination and the liquid would be treated at the Wastewater Treatment Plant (WTP). Since 2011, the biggest WTP of the city called ETE SUL, started receiving this material from almost 1000 vacuum trucks every month. The average of reduction of oil content in the system was around 95%, and it didn't disturb the biological process. On the other hand, the residual WFOG was under unappropriated disposition and it was oven mixed with the common waste. WFOG is a low-cost feedstock and its conversion to renewable biofuels has environmental and economical appeals, overall to decrease to cost of production, to reduce the pollutant emissions. In this work, the potential to produce biofuels of the material from the separation chamber of the WTP was evaluated comparing with waste lard and frying oil, converting it in methyl esters and biooils, and the influence of some catalysers.

Materials and Methods

The biodiesel was prepared using 200 g of oil, 70 ml of methanol and 2 g of sulfuric acid (1% w / w) for 2 h at 60° C with stirring. The low fatty acid samples were then added to KOH and methanol in the proportion of 1:40 (1% w / w KOH and 40% V / m methanol) shaken for 2 h. Cracking reactions were done with 200 g of sample, (Mello, 2015) in the temperature range between 350 and 400 ° C. The catalytic cracking was done in the same manner with the addition of 1.0 mass% of copper acetate II and cobalt II (Sigma-Aldrich). Analysis of oils and fuels according to the following specifications: Specific mass (Density) at 20 ° (Anton Paar digital densimeter -DMA 35N), (Brazilian regulation ABNT NBR 7148)45, Kinematic Viscosity ASTM D445), Carbon Residue (ASTM D4530), Sulfated Ash (ASTM D 874), Acidity Index (ASTM 664), Iodine Index (EN 14111). Oxidation Stability Test at 110 ° C (EN 141125328, EN 15751) was made on a Rancimat model 743 equipment, Methrom. Total Sulfur Assay (ASTM D4294) was in HORIBA Sulfur in oil X-ray fluorescence equipment Analyzer, SLFA 2100. Infrared in a SHIMADZU IR Prestige-21 equipment, using attenuated total reflectance cell, ATR, with ZnSe prism. The scanning was between 600 and 4000 cm^{-1}, with 32 accumulated interferograms. High performance liquid chromatography (HPLC) was done on SHIMADZU CTO-20A equipment (UV-VIS detector $\lambda = 205$ nm), with solvent flow of 2 mL / min on Shim-Pack VP-ODS column (C18, 250 nm , 4.6 mm internal diameter), injection volume of 20 µl and solvent flow of 1 ml / min 56, with ultrapure solvents - Toluene 99.5%, hexane 97.0%, 2-propanol 99.5% And 99.0% methanol (Sigma-Aldrich). Inductively coupled plasma atomic emission spectrometry (ICP-OES) analyzes were performed on a Thermo Scientific, ICP 6000 Series ICP

Spectometers with argon source equipment. Nuclear Magnetic Resonance (NMR) spectra were obtained on a Mercury Plus 7.05T (300 MHz to ^{1}H) spectrometer using a 5 mm diameter probe using 0.05 mL of sample and 0.6 mL of chloroform Deuterated ($CDCl_3$) (Sigma-Aldrich) as solvent and internal standard.

Results and Discussion

The WFOG from sewage has no potentially toxic metals and low sulfur content if compared to diesel but a high degree of free fatty acids (FFA) showed in acidity indexes and High Performance Liquid Chromatography (HPLC), Rancimat, Infrared Spectroscopy and Nuclear Magnetic Resonance if compared with the other waste fats. All the samples had The biodiesel formed from these waste fats has the highest yield and presented mostly physical and chemical properties under the maximum limits established by the International Regulation and close to the petroleum diesel. The biooils produced from the pyrolysis obtained products with high acidity and viscosity and also presented some physical-chemical parameters in disagreement with those attributed to petroleum diesel. Bio-oil from frying oil formed a larger fraction of alkanes and alkenes compared to the other samples, which formed a mixture of hydrocarbons and carboxylic acids. The catalytic cracking generated products with higher acidity, carbon residue and viscosity.

Composition (%)	A	B	C
Fatty acid and monoglyceride	90	9	4
Diglyliceride	5	3	8
Triglyceride	5	87	87
Methyl esther	0	1	1

Table 1-Composition of the crude samples from HPLC: A) Fat from sewage, B), Waste lard, C), Frying oil

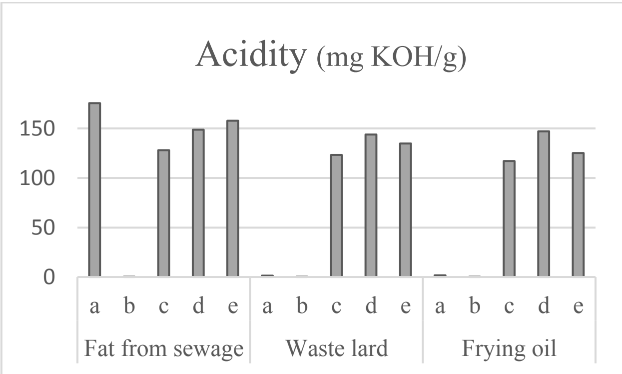

Figure 1- Acidity index: a) crude FOG, b)biodiesel, c) biooil, d) biooil with Cu cat., e) biooil with Co cat.

Conclusion

The waste fat oils and greases of this work showed a low content of sulfur and had no potentially toxic metals and its conversion to renewable biofuels has environmental and economical appeals, overall to decrease to cost of production, to reduce the pollutant emissions and to give a destination to this waste which often goes to landfills. Brazilian and international standardization ask to blend the biofuels with petroleum diesel to settle the likely properties.

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