Journal of Materials Science and Engineering B 4 (12) (2014) 396-400
doi: 10.17265/2161-6221/2014.12.011

Granulometric Distribution and X-Ray Diffraction of Two Brazilian Clays Used for Purification of Post-Consumption Vegetable Oils

Elaine Patrícia Araújo, Divânia Silva, Shirley Cavalcanti, Marcus Lia Fook and Edcleide Araújo
Department of Materials Engineering, Federal University of Campina Grande, Campina Grande, Paraíba 58429-900, Brazil

Received: October 08, 2014 / Accepted: October 31, 2014 / Published: December 25, 2014.

Abstract: Alternative fuels for diesel engines are becoming increasingly significant because of the decrease of oil reserves and thus, the increase in its price reaches levels that make impracticable to be used. The recycling of post consumption vegetable oils can help to reduce the disposal of these oils and have competitive price in the market. The aim of this study was to analyze by particle size distribution and X-ray diffraction two Brazilian clay (Tonsil and Aporofo) used for purification of vegetable oils after consumption for biodiesel production. To perform the particle size distribution technique for classifying particles by laser diffraction was used. The clays were characterized before and after the process of purification by X-ray diffraction. Techniques for particle size distribution and the X-ray diffraction analysis that were Tonsil clay showed better results in purification of vegetable oils after consumption compared to Aporofo clay. It could be concluded that the clays analyzed the Tonsil clay is the most suitable for the purification of post-consumer vegetable oils, withdrew because much of the impurities that were present in oils and gave him dark color and bad odor.

Key words: Treatment, vegetable oils, Brazilian clays, biodiesel, Campina Grande-PB.

1. Introduction

The clays are natural earth materials presenting chemically grained and are made up of hydrated silicates of aluminum, iron and magnesium. These are composed of small crystalline particles of a limited number of minerals and clay minerals. In addition to these clay minerals, clays may also contain organic matter, soluble salts, particles of quartz, pyrite, calcite and other residual amorphous mineral reserves [1].

The key factors controlling the properties of clays are: the chemical and mineralogical composition of clay minerals and nonclay minerals and their particle size distributions; content of exchangeable cations and soluble salts; nature and content of organic components and textural characteristics of the clay [1].

The determination of the technological properties and result of these properties are as a complementary function test results as traditional characterization: X-ray diffraction, X-ray fluorescence and particle size analysis. With these results added to the results of the technological properties it is possible to indicate the proper use of clay and establish specific or necessary properties for better performance to which the clay is subjected.

The importance and diversity of use of clays is a result of its specific characteristics. This diversity makes the clays of the most used materials, either on his great geological variety or offers a set of essential and indispensable factors in numerous industrial processes [2].

In the oil industry, the clays that are used for the treatment of post consumption oils are termed "bleaching earth", "bleaching earth", "clay fining" or "adsorbent clay" to indicate that clays in their natural state or after activation chemical or thermal, have the

Corresponding author: Elaine Patrícia Araújo, master, research fields: recycling of materials and microbial degradation. E-mail: elainepatriciaaraujo@yahoo.com.br.

property of coloring materials present in adsorbing mineral oils, vegetable and animals [3].

Much research is being developed for the treatment of post consumption vegetable oils mainly due to the issue of the depletion of oil and its derivatives and the search for renewable [4] energy.

Alternative fuels for diesel engines are becoming increasingly significant because of the decrease of oil reserves and thus, the increase in its price reaches levels that make impracticable to be used. Also the environmental impact caused by emissions of greenhouse gases generated from the burning of fossil fuels have been the reason for research on alternative energy sources [5].

Several studies have shown that the achievement of methyl and ethyl esters from vegetable oil is recommended post consumption because smaller feature incomplete hydrocarbon combustion and result of lower emissions of carbon monoxide and oxides of nitrogen [5, 6].

Biodiesel is a renewable alternative fuel that releases less harmful gas emissions compared to conventional fossil fuels such as diesel. The use of this oil for biofuel production brings advantages the environmental point of view, and presents the best price x effectiveness, in terms of collection and recycling. The production of this fuel with similar to fossil diesel is accomplished through a transesterification reaction, which aims to decrease the viscosity of vegetable oil to values of the viscosity of diesel oil [7, 8].

In Brazil, for almost half a century, various researches on biodiesel were developed, promoting initiatives for uses in testing and was one of the pioneers when registering the first patent on the process of fuel production. In the government of President Luiz Inacio Lula da Silva, through the National Program for Production and Use of Biodiesel (NPPB), the Federal Government organized the production chain, defined lines of financing, structured technological base and edited the new regulatory framework fuel. This interagency program of the Federal Government aims to implement sustainable way, both technically, and economically, the production and result of use of biodiesel, with a focus on social inclusion and regional development by generating employment and income. The main guidelines of PNPB are [9]:

- Implement a sustainable program, promoting social inclusion;
- Ensure competitive prices, quality and supply;
- Producing biodiesel from different oil sources and result of in different regions.

Residual oils from frying usually result in undesirable changes in the oil. At the frying temperature (170 to 180 °C) no reactions with air, water and food components. The oil and result of the vegetable fat used in frying process by immersion pose a serious risk of environmental pollution since most commercial establishments (bars, restaurants, cafes) and residential discards the residual oil into the sewer system difficult to treat these. However, this material can be used as feedstock for biodiesel production [10, 11].

The transformation of the used cooking oil into biodiesel brings significant environmental improvements. Initially the byproduct that would be discarded in the environment receives a new use, no longer willing improperly. Thus, reducing the consumption of fossil fuels (diesel oil) occurs, in addition to encouraging the use of renewable fuels.

For the manufacture of biodiesel, it is necessary to invest in an industry transformation and purification of oils. Biodiesel is biodegradable fuel derived from renewable sources (vegetable oil or animal fat) which can be obtained by different processes: cracking, esterification and transesterification [12].

The post consumption vegetable oils as alternative fuels have advantages over conventional diesel because it is a natural, renewable liquid with high energy, low sulfur content, low aromatic content and biodegradable. However, the use of these oils in biodiesel production requires prior to transesterification reaction, which comprises the removal of solid particulate contaminants and the appropriateness of color and odor [13] treatment.

The objective of this research was to evaluate the potential of two Brazilian clays in the purification of post-consumption for biofuel production plant oils.

2. Materials and Methods

2.1 Ceramic Material

The calcic clays used for purification of vegetable oils were the trade name of bentonite Tonsil and Aporofo clays with a particle size of #200(0.074mm) provided and identified by the company BENTONISA - Bentonite Northeast S/A, located in João Pessoa-PB .

2.2 Post- Consumption Vegetable Oil

Samples of post consumption vegetable oils without treatment were collected in homes located in the city of Campina Grande-PB/Brazil. These oils had dark color and unpleasant odor. A sample of virgin vegetable oil from soybeans was acquired in a business in order to make a comparison with the samples of vegetable oils untreated post consumption and post consumption-treated clays under study. Soybean oil was chosen because it is the most widely used in the domestic market and for its low commercial value in relation to other edible vegetable oils, such as olive oil, sunflower oil and corn oil.

2.3 Laboratory Test

Fig. 1 shows the flowchart of the methodology used for the bleaching of Treaties with calcic bentonite clay, Tonsil and Aporofo, Paraiba region of post-consumer vegetable oils. This method was adapted from Santos' literature [1].

2.4 Techniques for Characterization

The clays were characterized before and after the process of purification by X-ray diffraction using a Shimadzu XRD-6000 brand, with Ka radiation of copper (λ = 1.541 Å) operating at 40 kV and 30 mA, and speed of scan of 2°/min, belonging to the characterization of Materials Engineering/CCT/UFCG laboratory. Samples were analyzed in the range of 1.5-30° and Bragg's law for calculating the basal interplanar spacing was used [1].

To perform the particle size distribution technique for classifying particles by laser diffraction was used. The bentonite clay was sieved #200 (0.074 mm). The equipment used was a laser particle size analyzer Model 1064 Liquid CILAS. These analyzes were performed at the Laboratory of Characterization of Materials Engineering/UFCG.

3. Results and Discussion

3.1 X-Ray Diffraction

Fig. 2 shows X-ray diffractograms of bentonite clays before and after the bleaching process of the post-consumer vegetable oils.

Through the XRD patterns of bentonite clays, can be observed structural changes of clay and Tonsil Aporofo before and after the process of bleaching of vegetable oils. All feature a diffraction peak (001) referring to the clay mineral montmorillonite reflection in 2θ = 5.2° corresponding to a basal interplanar spacing (d001) of 17 Å, calculated by the Bragg equation. The other peaks at 2θ of 19.94°; 20.74° and 26.62° shows that clays present study accessory quartz as a material, and the peaks at around 2θ 11.6°, 12.16° and probably show the presence of mica, illite, respectively. The peak at 2θ around 28th is possibly the illite [13].

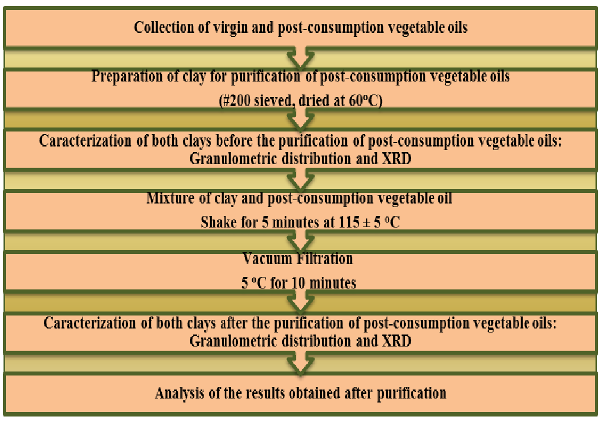


Fig. 1 Steps in the treatment of post-consumer vegetable oils process.

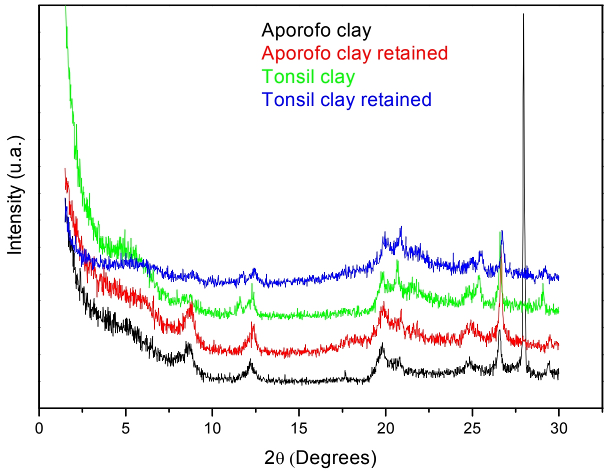
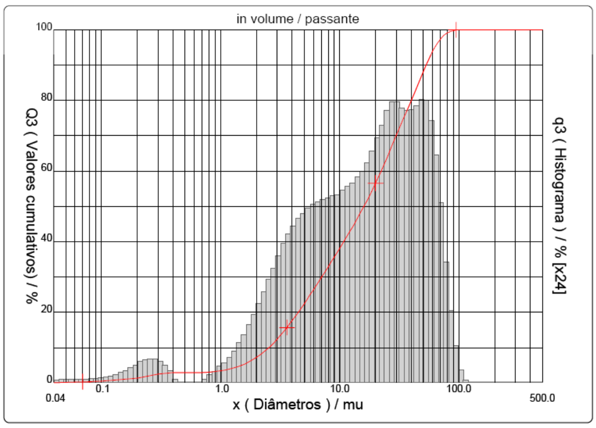
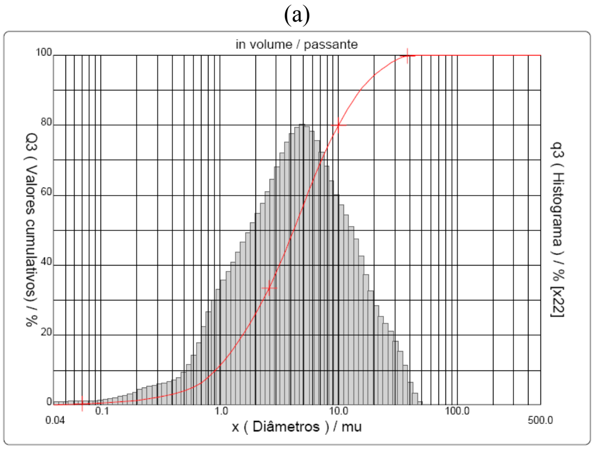


Fig. 2 X-ray diffraction of bentonite clays before and after the purification process.



(a)



(b)

Fig. 3 Particle size distribution of clays: (a) Tonsil and (b) Aporofo before the purification process.

In the XRD patterns of bentonite clay retained on the filter, it is observed that the angle of reflection characteristic of the clay mineral montmorillonite (2θ = 5.2°) showed less intense peaks, which may indicate a decrease in crystallinity compared to bentonite clay prior to Procedure bleaching showing the capacity retention of colored particles dispersed in oil by clay according Santos (1992).

Another important aspect that should be mentioned is that the clay retained Tonsil apparently has a more amorphous structure compared to Aporofo clay, as observed in the XRD patterns. This may show a greater efficiency of Tonsil clay in relation to Aporofo in the adsorption capacity of the pigments present in oils, but also reported by Souza [14].

3.2 Particle Size Distribution

Figs. 3a and 3b show the results of particle size distribution.

Can be seen by Fig. 3b that the Aporofo clay has a distribution of clusters of smaller pores as compared to the Tonsil clay (Fig. 3a). The average diameter of Aporofo was 6.49 m and the Tonsil was 22.36 μm. Although the average size of the agglomerates Tonsil clay has been increased, there was obtained a superior result in the bleaching action of this clay. This fact can be attributed to its higher chemical activity. It can also give this effect to a higher percentage of finer particles of clay and Tonsil that associated with the chemical composition resulted in a higher purifying effect.

4. Conclusions

The bentonite clay under Tonsil These experimental conditions showed the potential of vegetable oil bleaching more effective When Compared to Aporofo bentonite clay, since clay has removed much of the impurities in the oil.

The effective treatment of Tonsil clay was confirmed by comparative analysis of X-ray diffraction the two clays tested. The highest percentage of finer particles size distribution may show the Tonsil clay was more efficient in the purification process of the oil Aporofo compared to clay.

The bentonite clay Tonsil can be considered more efficient for the treatment of vegetable oils, since, Showed better results for this purpose than Aporofo clay.

Acknowledgments

The authors thank the Federal University of Campina Grande (UFCG), the Post-Graduate Program in Science and Engineering of Materials (PPGCEMat), BENTONISA NORTHEAST S.A, the company LUBECLEAN- Distributor Cleansing and Lubricants LTD, MCT/CNPq support and by financial scholarships.

References

[1] P.S. Santos, Science and Technology of Clays, 2 ed. Editora Edgard Blücher Ltda, São Paulo, 1989, p. 408.

[2] R.P.S. Dutra, M.L. Varela, R.M. Nascimento, U.U. Gomes, C.A. Paskocimas, P.T. Melo, Evaluation of the potential of clays of Rio Grande do Norte: Brazil Industrial ceramics, São Paulo, v. 11, 2006, pp. 42-46.

[3] P.S. Santos, Science and Technology of Clays, 2 ed., Editora Edgard Blücher Ltda, São Paulo, 1992, pp. 650-673.

[4] A.B. Bhattacharya, M.G. Sajilata, S.R. Tiwari, R.S. Singhal, Regeneration of thermally polymerized frying oils with adsorbents, Food Chemistry 110 (2008) 562-570.

[5] E.A. Torres, H.D. Chirinos, C.T. Alves, D.C. Santos, L.A. Camelier, Biodiesel: fuel for the new century, Bahia & Data Analysis, Salvador 16 (2006) 89-95.

[6] S. Murillo, J.L. Miguez, J. Porter, E. Granada, J.C. Moran, Performance and exhaust emissions in the use of biodiesel in outboard diesel engines, Fuel 86 (2007) 1765-1771.

[7] T. Issariyakul, M.G. Kulkarni, L.C. Meer, A.K. Dalai, N.N. Bakhshi, Mixtures of Biodiesel production from used cooking oil and canola oil, Chemical Engineering Journal Canada 140 (2008) 77-85.

[8] P. Felizardo, M.J.N. Correia, I. Raposo, J.F. Mendes, R. Berkemeir, J.M. Embroidery, Production of biodiesel from waste frying oils, Waste Management 26 (2006) 487-494.

[9] National Program for Production and Use of Biodiesel (PNPB), www.biodiesel.gov.br. (Accessed on June 9, 2009).

[10] M.G. Tiritan, E.S. Ferreira, Production of biofuel from cooking oil with hydrated ethanol using factorial design, in: Proceedings of the II Congress of the Brazilian Biodiesel Technology Network, Brasilia, 2007, pp. 1-6.

[11] C.A. Castellanelli, Study the feasibility of producing biodiesel, obtained through the used frying oil in the town of Santa Maria-RS, Dissertation (Master in Production Engineering), Engineering Institute of Paraná, Federal University of Santa Maria, Santa Maria, 2008.

[12] C.V. Silva, Recycling of cooking oil as a theme in environmental education classes, Academic Work Oriented (Graduate in Chemistry), Center for Science and Technology, State University of Paraíba, PB, Brazil, 2010.

[13] H.J. Dantas, Study thermoanalytical, kinetic and rheological biodiesel derived from oil cotton (*Gossypium hisutum*). MS Thesis (Chemistry/Analytical Chemistry), Center Exatas Science and Nature. Federal University of Paraíba, João Pessoa, 2006.

[14] C.D.D. Souza, Thermal regeneration of commercial clays for reuse in the clarification of soybean oil, MS Thesis Chemical Engineering), Integrated Technologies Laboratory, Federal University of Santa Catarina, Florianópolis, 2002.