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Engineering Properties of Kaolinitic Clay with Potencial Use in Drugs and Cosmetics

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ABSTRACT: *The Clays are one of the oldest raw materials available. They are minerals abundant around the world and, currently, when the societies are more interested in environmentally correct products, clays appear as an important alternative, because they are environmentally-friendly materials. In this study, our objective is to describe some properties of one Brazilian kaolin clay for use in drugs and cosmetics. The kaolin sample was characterized by X-ray diffraction, optical microscopy, scanning electron microscopy, swelling capacity and cation-exchange capacity. Our results show that the analyzed kaolin sample has potential for use in cosmetics.*

I. INTRODUCTION

Clays are a powerful and abundant material in nature, presenting several properties which may justify ~~your~~ their use in many industrial applications. They can be used as a raw material in several industry segments, such as civil construction and oil wells, chemical, white ceramic, food, drugs and cosmetics, filler for polymers, and others [1, 2]. For each application the engineering properties of the clays must be carefully designed to obtain the desired result.

Clays are usually defined as natural materials presenting fine granulometry. Often, these materials exhibit a lamellar structure as a consequence of the crystalline arrangement formed by the silicon and aluminum oxides, which are the main components of clays. These structures displayed by these materials, tetrahedral for silicon oxide and octahedral for aluminum oxide combine to form a unique structural arrangement in which sheets of tetrahedral and octahedral overlap each other, leading to structural changes such as 2:1 (one octahedral sheet between two octahedral sheets) and 1:1 (one tetrahedral sheet to one octahedral sheet) that characterize the various clay minerals [3, 4]. Bentonite and kaolin clays, the most studied clays, presenting structure 2:1 and 1:1, respectively. The searched engineering properties in these clays are related to their structures, and may be described by chemical composition, granulometric distribution, swelling capacity, morphology, plasticity, resistance, and cation-exchange capacity. Besides the main clay minerals expected to be found in given clay, other clay minerals, accessory minerals, and unwanted components [5], can be found in natural clays, in a composition that may invalidate their use in industrial applications such as pharmaceuticals and cosmetics. In this way, the degree of purity of the clay is an important property for various applications. [6]. On the other hand, the mineralogical standard presented by clay can maximize its use for a particular application.

The clays, as minerals originated from volcanic eruptions usually, weathering or hydrothermal alteration of crystalline rocks (Fig. 1), may contain in addition to the characteristic clay minerals, trace elements which might be toxic to health depending on their quantity in sample (e.g., Pb, Cd, Hg and others), and accessory minerals or impurities such as quartz, feldspar, mica, pyrite and carbonates, or rutile in varying concentrations. Therefore, depending on their final application, the clay must undergo a process of purification to remove undesirable impurities and ensure the reproducibility of results.

rock mother + water $\xrightarrow{\text{heat}}$ **clay (clay mineral, acessory minerals, non-clay minerals)**

Figure 1. General Scheme of formation of clays and clay minerals.

The kaolin clay, also known as "china clay" is chemically a hydrous aluminum silicate characterized as very fine powder, chemical inertness and lamellar structure (1: 1). In addition, its properties such as color, softness, and small particle size make it a suitable material for various industrial applications.

Kaolins with high purity, in their natural or modified form, are used in the formulations of drugs and cosmetics, primarily as inert charges, but they can also to act as active ingredients, used in medicines for stomach disorders and cosmetic muds. [7].

In this work, we describe the characterization and main engineering properties of a Brazilian kaolin clay to investigate its potential for use in drugs and cosmetics.

II. EXPERIMENTAL

II. 1. Material

In this paper we used a sample of kaolin from São Paulo, Brazil. The sample as received, crude sample, presented white color and was dried at 60°C before use.

II.2. X-ray diffraction (XRD)

The X-ray diffract gram for the sample of kaolin clay was obtained by powder method, using X-ray diffraction from Philips apparatus, X´PERT MPD model, operating in Cu Kα radiation, at 40kV and 40 mA, at a scan speed 2Θ/s = 0.020 and step of 1s, to observe the presence of characteristic clay minerals and accessory minerals.

II.3. Optical microscopy

For this analysis, 1.0 g of sample was added to 50 mL of deionized water, under mechanical agitation during 15 minutes. After shaking the dispersion was transferred to a glass slide of 18 x 18 mm in size, and taken to an oven at 60°C, overnight. The slide containing dry sample was analyzed by optical microscopy in Zeiss Stemi-2000C equipment.

II.4. Scanning electron microscopy (SEM)

Scanning electron microscopy of sample was performed in a LEO 440 device, equipped with Si(Li) solid state detector in X-ray energy dispersive spectrometry, to access the morphology of the kaolin, which was placed on stub, coated with gold in EMITECH K550 sputter coater.

II.5. Swelling capacity

The swelling performance of crude clay has been evaluated based on Foster method [8]. Shortly, 1.0 g of sample has been slowly added to 100 mL graduated cylinders containing 50 mL of deionized water, 10% solutions of sodium lauryl ether sulphate (SLES) and cethyl trimethylammonium chloride (CTAC), and allowed to stand overnight.

III. RESULTS

The result of swelling test for the sample was 2 mL/g, indicating that the sample presents no swelling capacity in the analyzed solvents. However, this was expected due the 1:1 structure of the kaolin clays. Micrographies by SEM showed that the sample is essentially constituted by lamellar structures (Fig. 2). The X-ray diffractogram of the sample (Fig. 3a) revealed the existence of peaks at d_{001}=7.14 Å and d_{001}=3.5 Å for the kaolinite claymineral, peak at d_{001}=10.0 Å attributed to mineral mica, and peak at $d_{001=}$3.3 Å related to quartz. By optical microscopy we observe that the analyzed kaolin sample presents a white powder with some silver points, probably related to mica mineral (Fig. 3b).

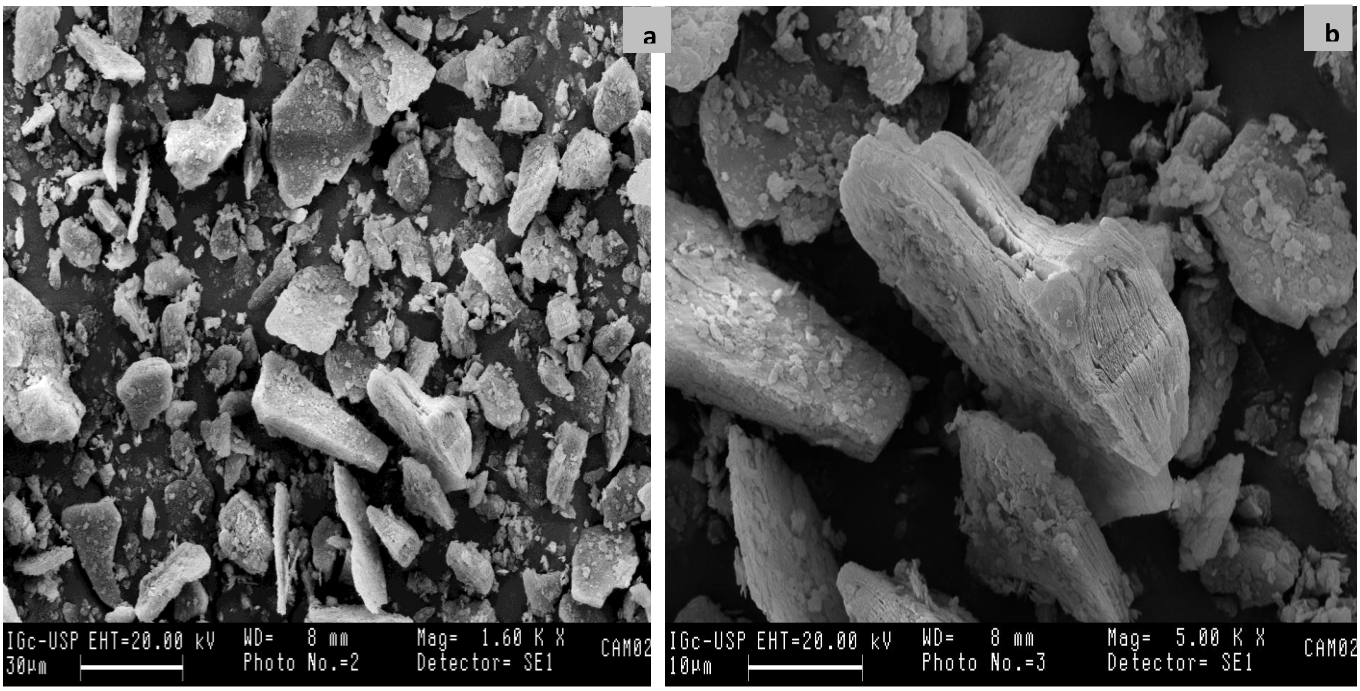

Figure 2. Images of kaolin clay by SEM showing lamellar structure, with different increases: a) 1600X; b)5000X.

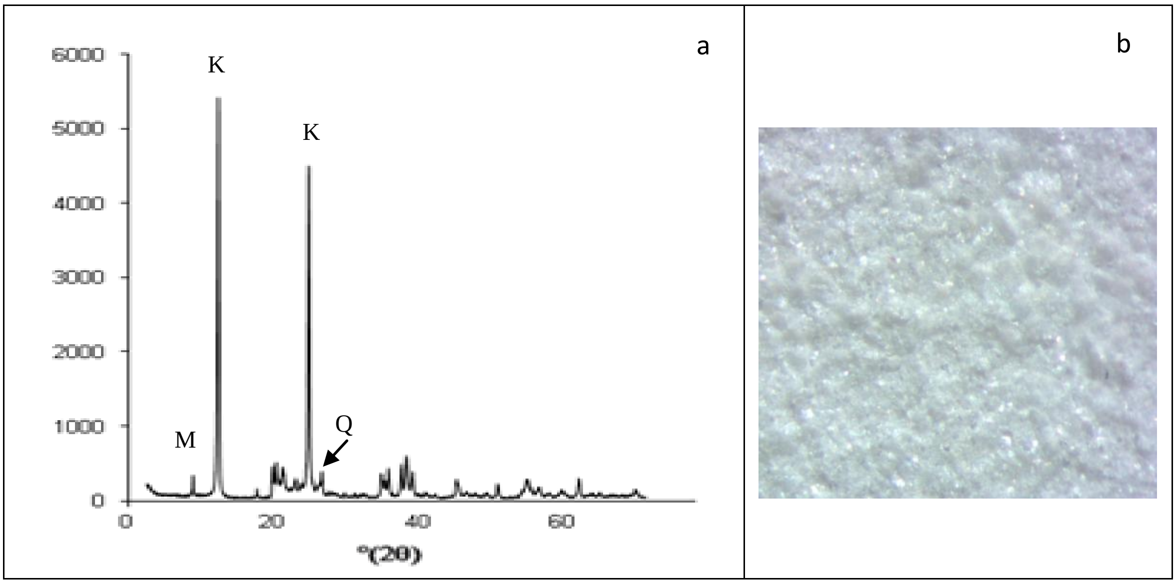

Figure 3. Shows XRD diffractogram (a) and image by optical microscopy (b) for kaolin sample (M=mica, K=kaolin, Q=quartz.

IV. CONCLUSION

Our results showing that the analyzed sample is mainly constituted by kaolinite clay in major concentration, and mica in minor concentration, what was confirmed by optical microscopy. This clay composition might be adequate for some applications of kaolin in cosmetics, since mica is added to some formulations of lotions and emulsions in order to donate brightness. In addition, the analysis by scanning electron microscopy revealed that the kaolin sample analyzed in this work is constituted of kaolinite clay mineral, as evidenced by the lamellar structure observed in the micrographies. These described properties indicate that the sample presents potential to use in cosmetic. However, purification proceedings, and other characterizations, must be performed to ensure its use both in cosmetics as topical drugs.

V. ACKNOWLEDGMENT

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REFERENCES

[1] H.H. Murray, in Applied clay mineralogy-occurrences, processing and application of kaolins, bentonites, palygorskyte sepiolite, and common clays, in Development and clay science, 2 (Amsterdam: Elsevier, 2007)85-110.

[2] A.R.V. Silva and H.C. Ferreira, Argilas bentoníticas: conceitos, estruturas, propriedades, usos industriais, reservas, produção e produtores/fornecedores nacionais e internacionais. Revista Eletrônica de Materiais e Processos, 2 (2008)26-29.

[3] Grim, R. E. Clay Mineralogy (New York: McGraw Hill, , 1962).

[4] F.R. Valenzuela-Díaz, P. Souza-Santos and H. Souza-Santos, A importância das argilas industriais brasileiras II. Quimica Industrial, 44 (1992)31-35.

[5] K. A. Carrado, S. Decarreau, S. Petit, F. Bergaya and G. Lagaly, Synthetic clay minerals and purification of natural clays, in F. Bergaya, B.K.G. Theng and G. Lagaly (Eds), Handbook of clay science, 1 (Elsevier, 2006) 115-139.

[6] M.G. Silva-Valenzuela, F.M.S. Carvalho, I.J. Sayeg, L.G. Sant'Anna, F.R. Valenzuela-Díaz, Purification and characterization of a natural Brazilian clay blend. Materials Science Forum 727-728 (2012) 1439-1443.

[7] A. López-Galindo, C. Viseras, P. Cerezo, Compositional, technical and safety specifications of clays to be used as pharmaceutical and cosmetic products. Applied Clay Sciences, 36(2007)51-63.

[8] M.D. Foster, Geochemical studies of Clay minerals II – Relation between ionic substitution and swelling in montmorillonites. American Mineralogy 38(1956)994-1006.