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Physicochemical Characterization of Intercalated Kaolinite

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physicochemical characterization of intercalated kaolinite

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Abstract. This work aims in particular the characterization of a hydrothermal clay of eastern Algeria, intercalated by cationic surfactant (DTAC). The intercalation is intended to space the sheets (the interlayer space) of the material as far as possible and to widen the advantages of its basal distances, as well as to increase its hydrophobicity. The preliminary study of this material was made using several methods: X-ray diffraction characterization, scanning electron microscope analysis, ATG, ATD; chemical analysis and determination of specific surface area by BET analysis. The results obtained showed that this clay is of kaolinite type. The textural analysis of the intercalated kaolinite was made by the B.E.T method and the specific surface area of the intercalated clay is thus determined. This characterization aims more particularly at the study of the structural and textural properties, which could allow an exploitation of this material in different fields of specific applications, given its availability and its great economic interest.

1.Introduction

Kaolinite is one of the most common minerals [1]. It is naturally in the form of clay particles. The presence of clay in soils can strongly influence mass transfer processes in natural environments. Kaolin, nonmetallic mineral filler [2], is used widely in ceramic, papermaking and coating, etc., pigments, and aluminum.

The knowledge of the structure and surface properties of kaolinite is essential to optimize the applications already mentioned [3]. Therefore, the characterization of the surface properties of kaolinite and other divided solids is fundamental [4].In this paper, we modified kaolin through using a cationic surfactant in order to increase the specific surface area.

2. Materials and Methods

2.1. Surfactant

The cationic surfactant was dodecyl trimethyl ammonium chloride (DTAC)), C_6H_5-$CH_2N^+(CH_3)_2C_{12}H_{25}N^-$ (NW = 384 g/mol), supplied by Fluka (purity > 99 %). The cross section areas per molecule at the air / water interface at 25 °C for DTAC is 47 $Å^2$. [5]

2.2. Adsorbant

The kaolinite-type clay used in this study was obtained from a region of Algeria. Its chemical composition was found to be as following:

43.82 % SiO_2, 0.20 % Fe_2O_3, 36.90 % Al_2O_3, 0.025 % MnO, 0.23 % CaO, 0.03 % MgO, 18.51 % H_2O. [6]

The Specific surfaces areas (SSA) were determined from adsorption of nitrogen at 77 K by applying the BET equation .The SSA of natural kaolinite measured is 48.75 m^2/g.

2.3.Preparation of modified kaolinite

The procedure is to disperse the kaolinite in water to obtain a completely delaminated clay. Then, it is introduced into a solution of alkyl ammonium ions, with a certain amount of quaternary ammonium DTAC, in order to carry out the exchange. The organic cations, thus released, are exchanged with the mineral cations and tend to occupy each exchangeable site of the surface. Once the reaction is complete, the organophilic clay is rinsed with bidistilled water, dried and milled to obtain it in powder form.

3.Results and discussion

3.1.Thermogravimetric analysis

Thermogravimetric analysis was performed using a TGA 2050 TA analyzer. Figure 1 of the thermogravimetric curve shows that an endothermic peak clearly accentuated at a temperature of 500-520 ° C corresponds to the occurrence of disorders of natural kaolinite.

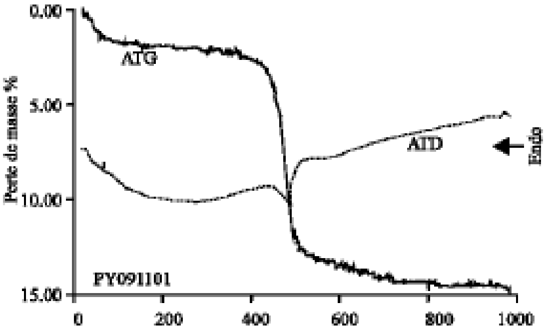

Figure.1: ATG curves, ATD of natural kaolinite

3.3.Electron scanning microscopy

The results of the characterization by scanning electron microscopy as shown in ‘figure 1’ indicate that the sample was uniform in content, containing a lot of tubular material, as well as large undesirable particle agglomerates.

Figure 2. Scanning electron microscopy Micrograph of kaolinite sample .

3.2. Determination of the specific surface area of modified kaolinite

The nitrogen desorption adsorption isotherm on intercalated kaolinite (Figure 3) is of type II in the BDDT classification, are characteristic of non-porous or microporous adsorbents, while the isotherm is marked by a low hysteresis at relative pressures. greater than 0.8: this must probably come from the residual porosity due to the uncompleted space between the particles.

The surface area obtained increased after intercalation of the cationic surfactant by 18 % (from 48.75 to 63.72 m^2g^{-1}). This specific surface area is significant compared to the surface of the kaolinite studied in the literature. [7]

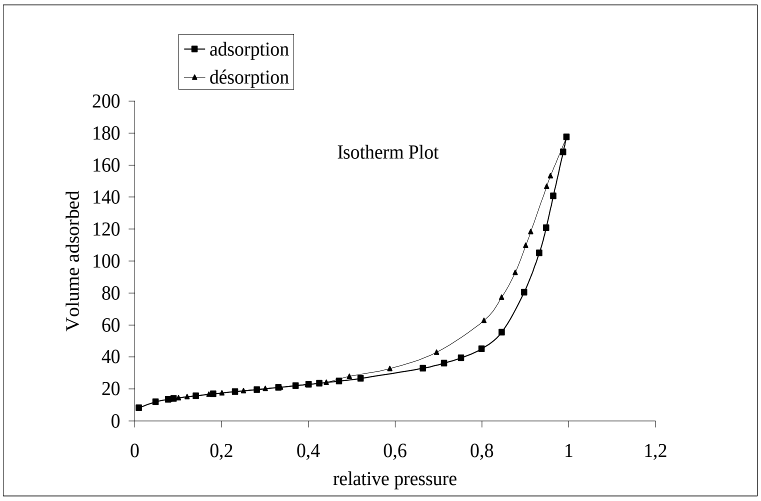

Figure 3. Adsorption / desorption isotherm of nitrogen on modified kaolinite.

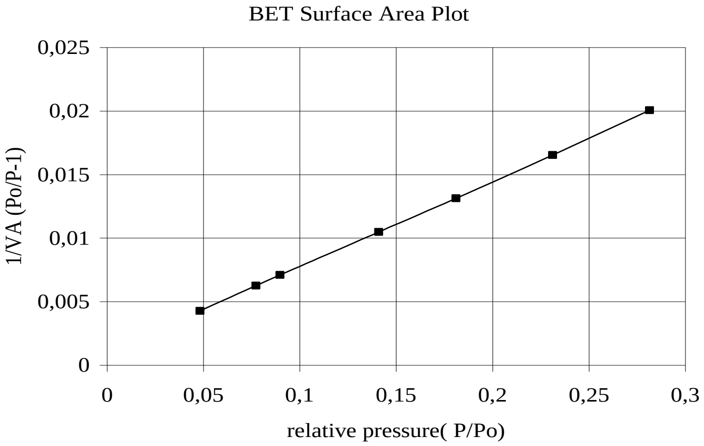

Figure 4. The BET transform of modified kaolinite.

4-Conclusion

The characterization results of this study show that the studied clay is of hydrothermal kaolinite type. The purpose of the cationic surfactant bridged clay was to increase the interlayer space and thus the specific surface area. The textural analysis by the BET method of this intercalated kaolinite allowed us to confirm the creation of a very dense microporous network and a high specific surface compared to the natural kaolinite.

5. References

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