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Rheological Properties of a Sodium Bentonite and Lactose Aqueous Dispersion

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Aim of this paper is show the viscosity measure of a sodium bentonite-water-lactose mixture and your rheological behaviour. This analysis showed the formation of tridimensional structure type and formation of stratified silicate/lactose, this occurred due to different concentrations of organic products into mixture and due to a difference of rotation during viscosity measument. Formation of networks is a consequence of the attraction between the silicate layers in water-lactose mixture. In the present work aqueous solutions of lactose with concentration of 7%, 5%, 3%, 1% and 0% (wt %) were used.

Introduction

Clay minerals, principally montmorillonites, offer a wide range of applications as adsorbent materials [1]. Clay layers in barriers may impede migration of toxic substances to the environment, in which case the effect of organic compounds on the particle-particle interaction and the mechanical stability of clay barriers must be considered [2]. The stability of band-like networks formed by partial overlapping of silicate layers and interlayer is affected by molecules and ions which are adsorbed on the external surfaces [3]. The evaluation of adsorbent materials effects can be done through viscosity measurements, in the present work some viscosity tests were done.
The viscosity measure of sodium bentonite-water-lactose mixture showed some rheological properties interesting to this mixture, like the Brasgel-water-ethanol system [4] and [5] to clay mineral sucrose system, which aqueous solution of sucrose and clays showed higher viscosity than the respective sucrose aqueous solution.
[4] observed that in a methanol range of 10% to 60%, the dispersion presented viscosity with values equal or higher than water-clay mineral dispersion, the highest value was of dispersion containing 20% of methanol. The dispersion containing more than 60% of methanol showed a viscosity smaller than water-clay mineral dispersion.
[6], observed the effect of viscosity increase in comparison to water-clay mineral dispersion with the same concentration of clay, to concentration ranges of organic compound like clay mineralwater-ethanol and in clay mineral-water-sucrose dispersion [5] e [7], observed the rheological behaviour of sodium bentonites-water-alcohols systems and suggested an explication to this kind of behaviour [4]: with the addition of alcohol the repulsion between particle reduced, until the point of touching each other with unions face-to-face, [5] however these faces are not completely overlayed, but partially, and formed a dispersion with tridimensional structure with higher values of viscosity than the water-clay mineral dispersion. After alcohol content increases it was observed that viscosity decreased because of a high attraction between particles, which contracted and broke the tridimensional structure. High amounts of alcohol form stratified silicate/alcohol, in which alcohol molecules stay on the interlayer space with a semi-crystalline arrangement [4].

Materials and Methods

Na-bentonite and lactose

A Na-bentonite from Wyoming (USA), supplied by Sigma Chemical Co., St. Lowis (USA) was used in natural form and was passed through an ABNT #200 screen. The flow behaviour of Wyoming bentonite dispersions was studied in water-lactose mixture without the addition of NaCl. A monohydrated lactose ($C_{12}H_{22}O_{11}.H_2O$, M = 360.32 g/mol) characterized as α-lactose monohydrated with water solubility at 20°C of approximately 8g/100g was used. Lactose was supplied by Ecibra Reagentes Analíticos (Brazil).

Viscosity measurements

For viscosity measurements was used a Viscosimeter Brookfield Model DV-II+ equipment of Brookfield Eng. Inc. Stoughton (USA). Five solution samples were prepared, five mixtures of 12g of Wyoming clay and 47g of water were put in 500 mL beckers. A mechanical homogeneization of the five mixtures was done after 4 this step blends stayed in rest for 24h. Then lactose solutions containing 7%, 5%, 3%, 1% and 0% (wt %) were added and shaken for 20 minutes. All dispersions stayed in rest for 24h. Finally, viscosities were measured. Room temperature approximately 26.5°C.

Results and Discussion

Figure 1 was observed that due to a low rotation and low concentrations, the system showed a high viscosity with a band-type networks [3] effect, which were formed by a partial overlay of silicates layers, by a tridimensional structure and in concentrations higher than 5%, in which lactose molecules stay on the interlayers space in a semi-crystalline order. To a little increase in rotation of Figure 2, stratified silicate/lactose with a concentration of 5% lactose would be formed, similar to interstratified silicate/alcohol with a semi-crystalline order [4]. In Figure 3 was observed a higher variation in the viscosity than in Figure 2, considering lactose concentration above of 5%. This increase was due to a higher agitation, that only occur from this concentration, as in tridimensional structure. Considering 5% concentration, the curve shows that the lactose stayed in interlayers space. In Figure 4, rotation used was higher than in the Figure 3. The heap of sodium montmorillonite particles, characterized by a semi-crystalline order, caused the suddenly viscosity decreasing, even lactose concentrations being lower than 5%. For lactose concentrations higher than 5% it was observed an increasing trend, it was also observed to Figure 5 curve. Therefore faces overlay partially, forming tridimensional structures band-like, when high concentrations of lactose and high rotations are used, as observed by [4].

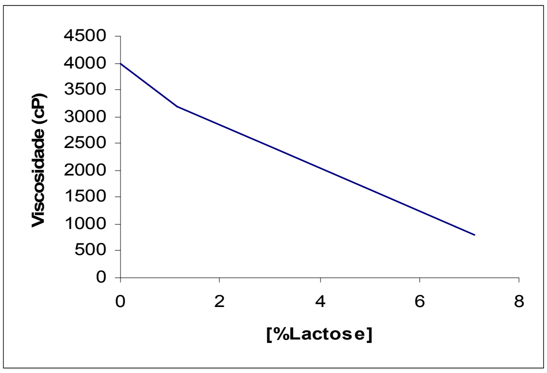

Fig. 1: Rotation of 0,5 rpm.

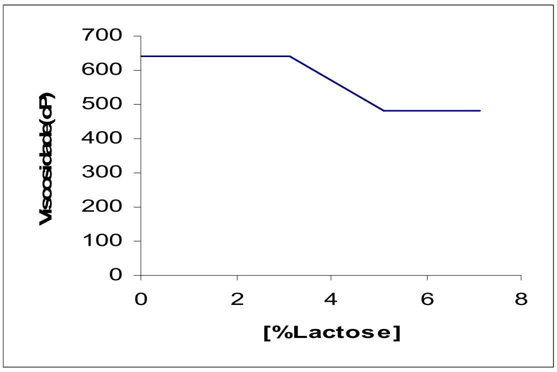

Fig. 2: Rotation of 2,5 rpm.

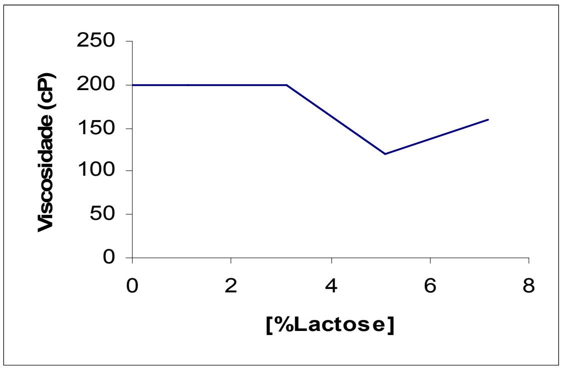

Fig. 3: Rotation of 10 rpm.

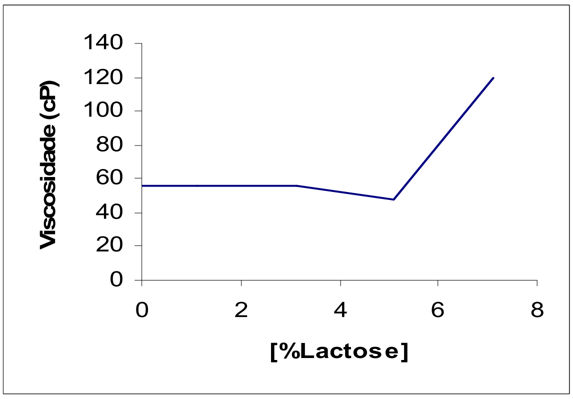

Fig. 4: Rotation of 50 rpm.

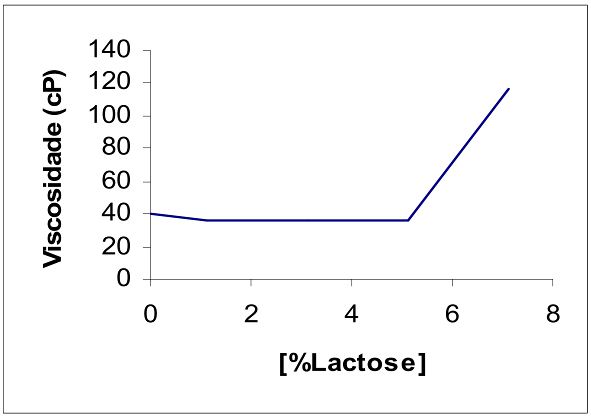

Fig. 5: Rotation of 100 rpm.

Conclusions

In the clay mineral-water-lactose system, considering concentrations above 5% under higher rotation, was observed viscosity decreases but it increases and present non-common rheological properties with formation of tridimensional structures in comparison to another concentrations. It was also observed that lactose stayed in the interlayer spaces with a semi-crystalline order for low concentrations.

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