PALYGORSKITE'S PELOTIZATION METHODOLOGY FOR ENVIRONMENTAL APPLICATION

METODOLOGIA DE PELOTIZAÇÃO DO ARGILOMINERAL PALYGORSKITA VISANDO SUA APLICAÇÃO AMBIENTAL

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ABSTRACT

Pelletizing is an agglomeration process with the objective of aggregating the share of ore fines in spheres with granulometry and quality suitable for direct use in the steelmaking process. It is used especially for iron ores, in order to concentrate them through processing in finer grains absent of impurities. Clayminerals such as palygorskite present fine granulometry (below 37 µm), fibrous and lamellar morphology, as well as micropores and channels in its structure, praising it as an alternative material in relation to its use in environmental issues. The objective of this work is to promote the pelotization of Guadalupe's palygorskite (Piauí/Brazil), aiming its environmental application as an adsorber of heavy metals such as lead and cadmium. Samples were accomplished the ore dressing by means of comminution in a jaw crusher, milling in a wet mill, followed by wet granulometric classification with a 20 µm sieve and wet magnetic separation in BOXMAG RAPID equipment in the field of 15 kGauss. Nonmagnetic's fraction below 20 µm was pelletized on a disc of 35 cm diameter, rotation speed of 50 rpm, inclination angle of 45° and pelletizing time time of approximately 20 minutes. Pelletizing's process used 10 and 20% w/w of glues based on PVA (polyvinyl alcohol) as agglutinative. The results indicate pellets physically resistant to friction, but which disintegrate in aqueous solution.

Keywords: pelletizing, palygorskite, polyvinyl alcohol.

RESUMO

A pelotização é um processo de aglomeração com o objetivo de agregar a parcela de finos de minério em esferas com granulometria e qualidade adequadas para a sua utilização direta no processo siderúrgico. Este processo é utilizado especialmente para minérios de ferro, de forma a concentrá-los por meio de processos de beneficiamento em grãos mais finos ausentes de impurezas. Argilominerais como a palygorskita apresentam granulometria fina (menor que 37 µm), morfologia fibrosa e lamelar, bem como microporos e canais em sua estrutura, enaltecendo-a como material alternativo no que tange à sua utilização em questões prejudiciais ao meio ambiente. Dessa forma, o objetivo deste trabalho consistiu em promover a pelotização do argilomineral palygorskita da região de Guadalupe – Piauí/Brasil visando a sua aplicação ambiental como adsorvedora de metais pesados como chumbo e cádmio. As amostras foram submetidas aos processos de beneficiamento por meio de cominuição em britador de mandíbula, moagem em moinho de barras a úmido, seguida por classificação granulométrica à úmido com peneira de 20 µm e separação magnética à úmido no equipamento BOXMAG RAPID em campo de 15 kGauss. A fração menor que 20 µm não magnética foi pelotizada em disco de diâmetro de 35 cm, velocidade de rotação 50 r.p.m, ângulo de inclinação de 45º e tempo de pelotamento de aproximadamente 20 minutos. Para o processo de pelotização foram utilizados 10 e 20% m/m de colas à base de PVA (álcool polivinílico), como aglutinante. Os resultados obtidos indicaram que as pelotas obtidas são resistentes fisicamente ao atrito, porém se desmancham em solução aquosa em diferentes pHs.

Palavras chave: pelotização, palygorskita, álcool polivinílico.

1. INTRODUCTION

Pelletizing is an agglomeration process with the objective of aggregating the share of ore fines in spheres with granulometry and quality suitable for direct use in the steelmaking process (Augusto, 2012). Pellets are spheres produced from concentrates and iron ores of different chemical and mineralogical compositions, with properties such as: uniform size distribution (in the range of 9 to 15 mm in diameter), high iron concentration (greater than 63%), high porosity (25 to 30%), practically without fire losses, with mineralogical uniformity, high and uniform mechanical characteristics and low tendency to abrasion (Nunes, 2004).

This process is used specifically for iron ores in order to concentrate them through beneficiation processes such as crushing, sorting, flotation and magnetic separation in finer grains absent of impurities such as silica and alumina (Borim, 2000).

It is necessary to search for new applications of pelletizing process in different types of minerals, especially those that have fine granulometry and micropores, aiming its application to solve environmental issues.

According to Murray 2000, clayminerals such as palygorskite have fine granulometry (below 37 μm), fibrous and lamellar morphology, as well as micropores and channels in its structure, praising it as an alternative material in relation to its use in matters that are harmful to the environment, especially due to its high specific surface and sorption capacity of different species types.

2. OBJECTIVES

The objective of this work was to promote the pelletizing of Guadalupe's palygorskite (Piauí/Brazil), aiming its environmental application as an adsorber of heavy metals ions such as lead and cadmium.

3. METHODOLOGY

Palygorskite's samples were accomplished the ore dressing by means of comminution in a jaw crusher, milling in a wet mill, followed by wet granulometric classification with a 20 μm sieve and wet magnetic separation in BOXMAG RAPID equipment in the field of 15 kGauss. Nonmagnetic's fraction below 20 μm was pelletized on a disc of 35 cm diameter, rotation speed of 50 rpm, angle of inclination of 45 ° and pelletizing time of approximately 20 minutes. The pellets were then oven dried, approximately, 50 °C.

In order to study the methodology required for palygorskite's pelletizing, the formation of pellets was tested using the systems shown in Table 1. It is emphasized that both granulated PVA (polyvinyl alcohol P.S.) and PVA-glues commercial were used as adhesives in the systems, in order to physically and chemically adhere to the clay-pellet aiming to give it a higher mechanical strength.

The pellets were analyzed in Zeiss Discovery V8 stereoscopic binocular microscope, for better visualization of their spherical shape, as well as in Scanning Electron Microscope (SEM) in microscope equipment, HITACHI TM303 Plus, for morphological analysis.

Table 1: Systems used in pelletizing process.

Systems	Constituents
1	Palygorskite and granulated PVA
2	Palygorskite and white glue
3	Palygorskite and transparent glue
4	Palygorskite and glue mixtures

4. RESULTS AND DISCUSSION

The results obtained were positive with respect to the homogeneity of the pellets, as well as their first resistance analysis, since they were well hardened, as expected.

For system 1 (Figure 1), could be observed that granulated PVA was found only on the pellet surface and was not incorporated into the medium. This fact can be explained due to its superior granulometry in comparison to the clay's granulometry, that made its grains resemble the crystals.

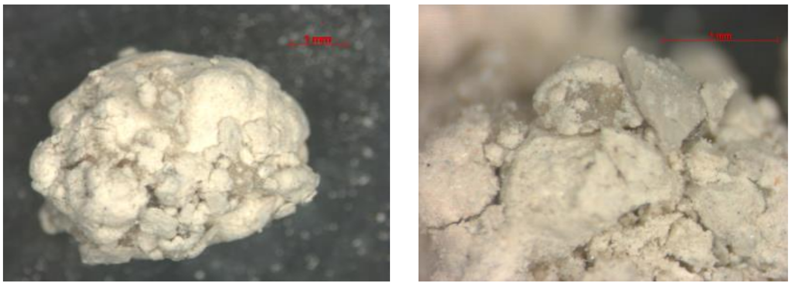


Figure 1: Pellets of palygorskite and granulated PVA.

To elucidate such use, PVA-based adhesives (white glue and transparent glue) were tested. Issues such as the solubility of these glues were encountered, since the white glue was highly soluble in distillated water and poorly soluble in ethanol (96% purity of sigma-aldrich) and the transparent glue insoluble in distillated water and poorly soluble in ethanol (96% purity of sigma-aldrich). The results obtained for systems 2 and 3 (Figures 2 and 3, respectively) were homogeneous and resistant pellets, but were slightly disintegrated in contact with aqueous solution. This fact can be explained due to an incompatibility in palygorskite/glue ratio.

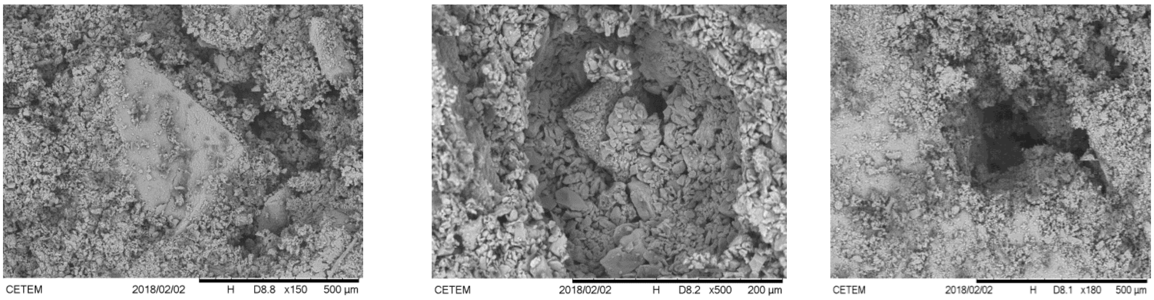
Figure 2: Pellet of palygorskite and white glue.

Figure 3: Pellet of palygorskite and transparent glue.

The test for system 4 was designed to counterbalance the solubility properties of each of the glues, in order to produce a pellet that would remain stable when submitted to the adsorption process whose performance is in aqueous medium. For this test the ethanol (96% purity sigma-aldrich) was used as the solvent. Due to difficulty with proportion, half of the pellets were resistant and another half easily crumbled (Figure 4). In addition, its appearance resembled pellet with granulated PVA.

Figure 4: Pellet of palygorskite and glue mixtures.

Analysis of images obtained by the Scanning Electron Microscope (SEM) for pellets with transparent glue, white glue and the mixture of both (Figures 5A, 5B and 5C respectively), indicated the presence of pores in pellets, which implys that the use of commercial adhesives does not detract the porosity of the material, not damaging its structure.



Figures 5A, 5B and 5C: SEM images of Pellets of palygorskite with white glue, transparent glue and glue mixtures, respectively.

5. CONCLUSIONS

From the results obtained it is concluded that the use of commercial glues based on PVA is promising as regards its application as adhesive, being able to adhere to palygorskite in order to pelletize it. Studies more detailed on palygorskite:glue ratio should be performed, since this proved to be an important variable in relation to the quality of the esphere produced. In addition, its insertion did not damage the microporous structure of palygorskite, a factor which has an extreme importance for the adsorption process.

Moreover, studies on the improvement of mechanical strength of the pellet should be performed, where the thermal activation process stands out as a viable alternative at controlled temperatures.

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