Iranian Bentonite Beneficiation for Nanoclay Application

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ABSTRACT

Purification of Iranian bentonite samples from Reshm mine using chemical agent (sodium hexametaphosphate) for nanoclay application was investigated. Mineralogical studies indicated that Na-smectite was the main clay mineral and cristobalite and quartz were the major impurities. In addition, sample contains small amounts of feldspar, gypsum, dolomite, calcite and zeolite as minor impurities. The samples were processed by crushing, attrition scrubbing followed by sedimentation treatment with sodium hexametaphosphate. After purification treatment, samples intercalated with octadecylamine and evaluated by XRD analysis. The results showed that application of such simple flowsheet effectively removed the majority of the associated gangues and produced high grade clay that had less than about 5% by weight non-Smectite impurities. After beneficiation, the particle size distribution for final product is appropriate for nanoclay production and d80 for purified montmorillonite particle was 2µ.

Keywords: Montmorillonite; Nanoclay; Octadecylamine; Intercalation.

INTRODUCTION

Bentonites are comprised predominantly of the Smectite group of minerals. The most common are Sodium and Calcium Montmorillonites. Calcium Montmorillonite is the most predominate of the Smectite minerals and is found in many areas of the world. Sodium Montmorillonite is relatively rare in occurrence in comparison with Calcium Montmorillonite. Exchangeable cations such as Sodium, Calcium, and Magnesium occur between the Silicate layers, associated with water molecules. The property of ion exchange and the exchange reaction are very important in many of the applications in which the Smectite minerals are used (Murray, 2007).

Nanoclays are ultra-fine clays usually considered to be less than 5 µm and commonly less than 2 µm. These ultra-fine clays are very reactive and when incorporated into polymers, ceramics, inks, paints, and plastics, give some exceptional functional properties. Their properties are due to the large surface area to volume ratios. Sodium Montmorillonite can be exfoliated to single platelets about 1nm thick, giving high aspect ratios in excess of 100:1. Nanoclays can be incorporated into many thermoplastic polymers, which give improved performance at much lower loadings than required for conventional fillers (Murray, 2007). Harris reported that 3–5% nanoclay loadings would compare with 10–50% loadings of conventional filler (Harris, 2003). Performance improvements include increased tensile strength, heat deflection temperature, and flame retardance (Harris, 2003).

Addition of exfoliated clay platelets to the polymeric materials has substantially enhanced one or more properties of the polymer, the addition of clay impurities together with the exfoliated platelets has caused a decrease in properties that the platelets are designed to increase. Thus exfoliated platelets obtained from the purified clay are sufficiently free from clay impurities to significantly enhance the desired properties of the polymer (Clarey et al., 2000; De Paiva et al., 2008).

Polymer-grade clay should have less than about 5% by weight non-Smectite impurities, preferably less than about 2% by weight non-Smectite impurities, including crystalline and amorphous impurities, in order to provide new and unexpected results in enhancement of polymer properties, when combined with the polymer in a nanocomposite composition (Clarey et al., 2000).

Various methods were presented for Bentonite purification, however between them two methods are well-known. In first method that presented by Tributh & Lagaly purification is based on chemical separating (Tributh & Lagaly, 1986). In recent years fast method based on mechanical separating presented by Amcol Inc. The Tribute & Lagaly method is based on separation various impurity by different process. This method is designed to remove as many impurities as possible to achieve a pure clay mineral. However, the purified material may still contain impurity like Quartz. Amcol method is based on passing the clay slurry through a series of hydrocyclones to remove the impurities, then centrifuging the clay to remove a majority of the particles having a size in the range of about 0.5 µm to about 100 µm. (Clarey et al., 2000;