EVALUATION OF SOME WATER-SOLUBLE DISPERSANTS FOR DIFFERENT TYPES OF KAOLIN POWDERS [+]

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Abstract

The ability of some different water-soluble natural and synthetic chemical compounds is evaluated to be used as dispersant for two types of kaolin, Merkhiat and J. Umm Ali. They are glycerin, glycerin jelly, poly(ethylene glycol) and Arabic gum.

The kaolin raw materials were grinded and fractionated by sieving process to five fractions to study the effect of different particle size on the final packing densities. They were had the following particle size: -90+32 µm, -90+75 µm, -75+63 µm, -63+53 µm, and –53+32 µm.

Sedimentation settlement under gravity was used to evaluate the quality of each dispersant. It was found that the type of dispersant and its concentration have an influence on the final packing density in addition to the particle size of the kaolin powders.

المستخلص

قُيمت قابلية بعض المركبات الطبيعية والصناعية ومن النوع الذائب في الماء لاستخدامهم كمواد مشتتة النوعين من الكاؤولين السوداني هما، كاؤولين منطقة مرخيات وكاؤولين جبل أم علي، والمواد هي: الكليسيرين، الكليسيرين الهلامي، بولي(أثيلين كلايكول) والصمغ العربي.

تم تنعيم المواد الخام الكاؤولينية وجزئت بعملية النخل إلى خمسة أجزاء حسب الحجم الحبيبي وكالتالي : 32+90- ، 75+90- ، 63+75- ،53+63− و 32+53- ما يكرون.

أستخدم فحص الترسيد بواسطة الجاذبية الأرضية لتعيين جودة كل مشتت. لقد وجد لنوع المشتت وتركيزه تأثير كبير على كثافة الرص النهائية بالإضافة إلى الحجم الحبيبي لمسحوق الكاؤولين.

Introduction

In recent years, there has been a rapid development in research on achieving good ceramics suitable for various applications, such as mechanical, thermal, chemical, etc. To produce ceramic product which meets the technology demands, has imposed requirements of producing high packing densities in the green state with closed packed, narrow-sized distribution powders and uniform interparticle pores. This

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requires control of both powder-production and packing [1,2]. However, it is Believed that the strength, homogeneity and quality of fired ceramic are difficult to meet while using crude powders as starting material.

Clay has always been the chief ingredient in ceramic industry, although many refractories and electronic bodies are made with little or no clay, nevertheless, kaolin and various types of clays are still our important ceramic raw materials [3]. The characteristic properties of clays are imparted by their main functional components, the clay minerals, which are aluminosilcates containing hydroxyl groups. The physical and technological properties of clays depend not only on the composition and structure of the respective clay minerals, but also on the particle size and shape [4].

Dry kaolin powders are always characterized as tightly bound aggregates of particles in direct contact with each other's at same time before dispersion. The chemistry of the particle surfaces is an important factor in the formation of aggregates, which cannot be subsequently broken up. However, the critical first stage in production of a good ceramic is to disperse the primary particles into the suspending solvent so that they are separated to a stable dispersion without aggregation. Therefore, the selection of dispersants to maintain particles in a deflocculated state is dependent on both the ceramic powder and the dispersion medium. Each powder has an optimum dispersant requirement that will fully disperse and not flocculate the particles. The concentration required will also vary with each dispersant [5,6,7].

This work aims to draw attention to some natural and synthetic industrial chemical compounds like, Arabic gum, glycerin, glycerin jelly and poly(ethylene glycol), which can be used as dispersants and to evaluate their actions in term of obtaining better packing densities for different types of Sudanese kaolin powders.

EXPERIMENTAL

Adsorbents

Two types of kaolin were used in this work. Kaolinite deposits located in the Merkhiat Hills northwest of Omdurman and in J. Umm Ali north of Shendi [8].

Dry grinding of both types of kaolin was carried out with ceramic ball mill type (E. W. Ltd., BS 215/Japan). The ground product kaolin was sieved using Podemorse sieving machine No. 15104/ England, the material retained on the sieve for each

fraction was weighed. Table (1) shows the particle size interval of each fraction used in this work.

Table (1): Merkhiat and Umm Ali kaolin fractions resulted from sieving process.

Code	I	II	III	IV	V
Particle size (µm)	-90+32	-90+75	-75+63	-63+53	-53+32

Dispersing Agents

Arabic Gum is the oldest and best known of all natural gums. It is successfully used in different applications, for example as a binder in pigments and cosmetics, and as an adhesive in painting. It was obtained in form of powder from GAPC of Sudan [9].

Also the ability of some polyhydroxylic alcohols; glycerin, glycerin jelly and poly(ethylene glycol), were tested as a dispersant of kaolin particles, and they are obtained commercially.

Dispersion Medium

Water was used as a suspension and washing medium because it is the most preferable solvent in the ceramic industry. It is also used in traditional shaping methods of throwing and modeling plasticity, which associated with is adsorbed water film around each clay particle.

Dispersion Process

Dispersions were prepared by mixing four grams of desired kaolin with a known concentration of the dispersing agent in a stoppered 10ml-graduated cylinder. They were agitated manually and ultrasonically for at least 1 hour, and then they were allowed to standing at room temperature until settling was complete. The height of the top surface of the solid bed was monitored as a function of time.

The packing density of the final particle bed is measured and expressed as a fraction of the theoretical density of a fully dense ceramic. For all the suspensions, the final packing densities were reproducible to within ±0.2 in repeated experiments with same conditions.

Perfect packing of spheres would yield a density of 74%; random close packing of spheres gives 69% density. Agglomerated particles typically settle rapidly to packing densities of the order of 20%. Dispersants giving packing densities in the range from 30% to 60% are currently regarded as good [1,2].

Results And Discussion

The enormous development and use in the last three decades of ceramics for high technology has been made possible only by the paralleled development in specific dispersants and lubrication process.

The steps to achieve well-packed sediment must include (a) deagglomeration and dispersion of the dry powder into the solvent, (b) settling of the powder without agglomeration due to interparticle attractive forces, and (c) high mobility and low friction within the sediment to allow optimum packing.

In any dispersion process although a ceramic slip should consist of individual particles stabilized against aggregation, the large density differences between the inorganic clay particles and the water means that the particles will usually settle out under gravity. Therefore, sedimentation density measurement is used to determine the ability of each type of dispersant to flocculate or deflocculated kaolin particles in the suspending medium. This allows comparison in terms of final sediment volume directly. Although all dispersants contributed to the dispersion of both types of kaolin particles some of them increased the packing factor more than the other were and affected by its concentration and by the size of particles.

Examining Fig. (1) concerning the packing densities obtained from Merkhiat kaolin in different concentrations of dispersant examined and comparing that with those in Fig. (2) of Umm Ali kaolin, having the same particle size (Code I, -90+32 μm), one can easily observe that higher packing densities is obtained with Merkhiat kaolin, Fig. (1 a) reflecting better dispersion was obtained originally from these suspensions [10].

Fractionation of the above code of particle size to smaller interval, code II to V, Table (1), enhances the packing densities of some sediments and slightly affects other sediments. Code II, for example, which is ranged between –90+75 μm can be consider the main fraction of kaolin particles had the largest particles that will fall rapidly during sedimentation process and occupy a volume at the base of the sediments, and this may affect the final packing density, which can be seen in Fig. (2). Almost all of the dispersant concentration act equally on both types of kaolin except

that of Arabic gum on Merkhiat kaolin, although the final packing densities were slightly lower than that of (code I) particle size. Other results for the rest of the particle size can be seen in Figs. (3), (4) and (5) for both types of kaolin.

From the above discussion of powder packing the emphasis has been placed on the second stage as being the key to achieving good packing by the elimination of the attraction between pairs of kaolin particles. We can say that increasing the number of hydroxyl groups in dispersant molecule has improved the sedimentation of kaolin powders in terms of packing density, although the active group was the same, i.e. hydroxyl groups. Doroszkowski and Lambourn [11] made similar observation. He found that increasing the length of the acetate side chain by just three ($-CH_2-$) links caused very large increase in stability. This implies that surface concentration is very important in influencing origin dispersions [12].

Conclusions

The following conclusions can be drawn out from this work:

1. The experimental results suggest that a wide range of water soluble compounds can be used as dispersants for kaolin particles and the sequence may be put in the following order:

   Arabic gum > poly(ethylene glycol) > glycerin jelly > glycerin

2. The packing density of the resulted kaolin sediment is influenced by the size of the particles used in the dispersion. Code I (-90+32) and Code V (-53+32) were the best.

3. Better packing densities were obtained with Merkhiat kaolin for all types of the dispersant used.

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