PARTICLE SIZE EFFECT ON DISPERSIBILITY OF KAOLIN POWDERS IN ARABIC GUM DISPERSANT[+]

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Abstract

Merkhiat kaolin powders were dry grinded in ceramic ball mill, and fractionated by sieving process to five fractions. They had the following particle size: -90+32 µm, -90+75 µm, -75+63 µm, -63+53 µm, and –53+32 µm.

The effect of these particle sizes on the dispersibility of Merkhiat kaolin powders in the presence of different wt% aqueous solution of Arabic gum as dispersant was studied. It was found that the particle size of the dispersed kaolin powder and the concentration of Arabic gum dispersant play an important role in the dispersion process.

المستخلص

تم تنعيم مسحوق كاؤولين منطقة مرخيات بواسطة طاحونة كرات سيراميكية، بعدها جزئ المسحوق المنعم جافاً بعملية النخل إلى الأجزاء التالية: 32+90- ، 75+90- ، 63+75- ،53+63− و -53+32 ما يكرون.

درس تأثير هذه الأحجام على تشتيت مسحوق كاؤولين مرخيات بوجود تراكيز مختلفة من المحلول المائي للصمغ العربي. لقد وجد بأن الحجم الحبيبي و تركيز الصمغ العربي يلعبان دوراً مهماً في عملية التشتيت.

Inteoduction

The dispersion stability of two types of kaolin, namely Merkhiat and J. Umm Ali, particles from different solutions of polyhydroxylic dispersants were examined in previous work [1,2]. It was found that better dispersion and good packing densities are obtained from these dispersants, and we can put them in order of: Arabic gum > poly(ethylene glycol) > glycerin jelly > glycerin, and Merkhiat kaolin being the best. On the other hand aggregations occuring with kaolin suspension having no dispersant.

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The purpose of the present work is to study the effect of kaolin particle size on the dispersion properties and the final packing of Merkhiat kaolin powder settled in the aqueous solution of Arabic gum, since 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 [3].

Experimental

Adsorbents

Clay deposits of different types and quality occur in many areas in Sudan [4]. For example, kaolinitic clay deposits are known to occur in several localities including those kaolinite deposits located in the Merkhiat Hills north west of Omdurman. It consists of 40-50% kaolinite, 40-55% quartz, and up to 2% goethite. Its chemical compositions showed the presence of some metal oxide in addition to the main two components of silica and alumina [2].

Dry grinding of Merkhiat kaolin was carried out in 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 were weighed. Table (1) shows the particle size interval of each fraction used in the preparation of dispersion.

Table (1): 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 Agent

The oldest and best known of all natural gums is Arabic Gum. Ancient inscription frequently used Arabic gum as a pigment binder and adhesive in painting, as a binder in cosmetics and inks, and as an agent in different mummification processes [5]. It was obtained as a powder from GAPC powder.

The physical, chemical and functional properties are functions of the gum structure and composition. Arabic gum is a complex macromolecule of a high molecular weight. It has an extremely high solubility in water, which is the dispersion medium used in this work. It is slightly acidic with a pH of about 4.5-5. In contrast to its high molecular weight, Arabic gum has low viscosity. High viscosities are not obtained up to concentrations of about 40-50%, therefore, a concentration ranging from 0.5-5% was used in this work..

Dispersion Process

Dispersants were prepared as reported in literature [6]. Four grams of kaolin were mixed with a known concentration of the dispersing agent in a stoppered 10ml-graduated cylinder. Components were mixed by shaking to make sure no powder remained stuck to the bottom, for at least 1 hour in ashaking machine, then the vessel was allowed to stand at room temperature until settling was completed. The settled volume was measured, at different time periods, until sedimentation was completed (up to one month). For all the suspensions, the final packing densities were reproducible to within ±0.2 in repeated experiments under the same conditions.

The volume of supernatant solution was measured using analytical pipette The differences between this volume and that originally used gives the void volume of the packed kaolin bed. Hence the packing factor can be calculated and expressed as the ratio of the total volume of the bed to the volume for total packing of fully dense clay. Packing densities in the range from 30% to 60% are currently regarded as good [7].

ResulTS And Discussion

Different suspensions of kaolin having different particle size and Arabic gum were prepared. We are not expecting that all particle sizes will behave similarly, although the type of kaolin and the dispersing agent were the same. Most of the conditions were kept constant including the amount of kaolin powders and total time of settling.

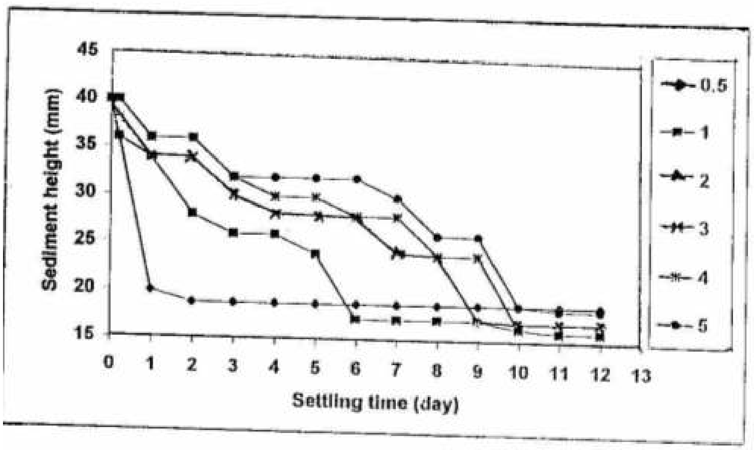

Figure (1): Sediment height of Merkhiat kaolin powders having particle size of (−90+32 μm) as a function of settling time in the presence of different wt% of Arabic gum.

Fig (1) compares the top particle height versus settling time for kaolin particles having particle size interval of –90+32 μm, suspended in different concentrations of Arabic gum. It can be seen that the particles needed about 10 days to complete their settling after standing in aqueous solution of Arabic gum, but they settled in similar trend except that of lowest concentration of Arabic gum, i.e. 0.5 and 1%. They settled nearly to the final sediment volume within the few days accompanying with faster rate than the others. In both cases sedimentation gave a sharp interface that moved through the solution, leaving a clear supernatant liquid above it. The resulting sediments were loosely packed. While the dispersions which had higher concentration of Arabic gum exhibited better dispersion, although sedimentation still involved a sharp interface and a clear supernatant liquid. The resulting sediments were much more densely packed. In most cases, the better packing was obtained from the system that had the slower sedimentation rate.

When kaolin particle size changes to group II, having a particle size of –90+75 μm, Table (1), almost two groups of settling can be distinguished as this interval of particle size is considered to have the fairly coarse particles of ground kaolin. The sedimentation was generally markedly faster and after some time three settling zones can be observed, especially with dispersion of 1% concentration of Arabic gum had Arabic gum, (Fig. 2).

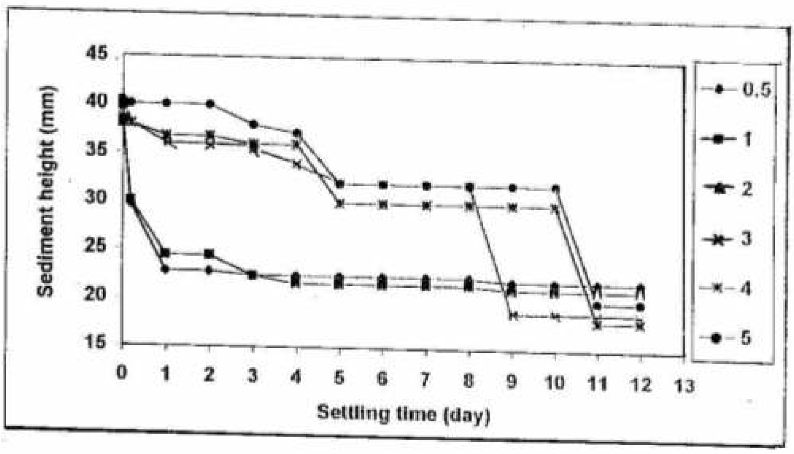

Figure (2): Sediment height of Merkhiat kaolin powders having particle size of (–90+75 μm) as a function of settling time in the presence of different wt% of Arabic gum.

The settling rate of the sediments is found to be sensitive to the particle size of kaolin powder. This can be further seen very clearly by comparison of results obtained for other dispersions of kaolin with particle size of grade III, IV and V (Figs. 3, 4 and 5).

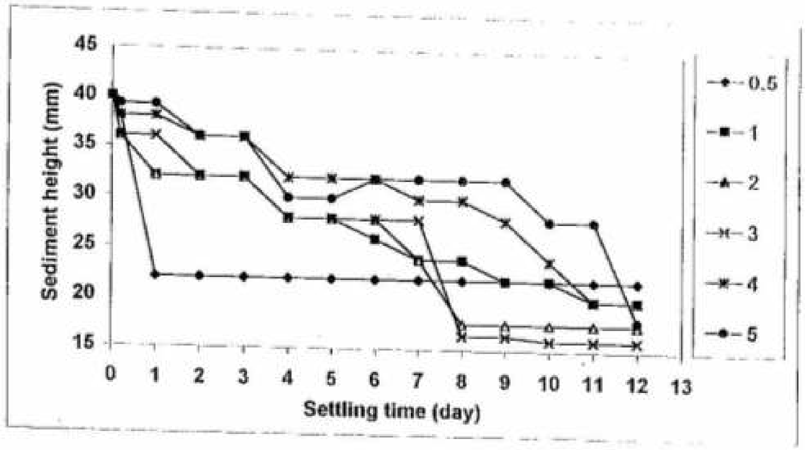

Figure (3): Sediment height of Merkhiat kaolin powders having particle size of (−75+63 µm) as a function of settling time in the presence of different wt% of Arabic gum.

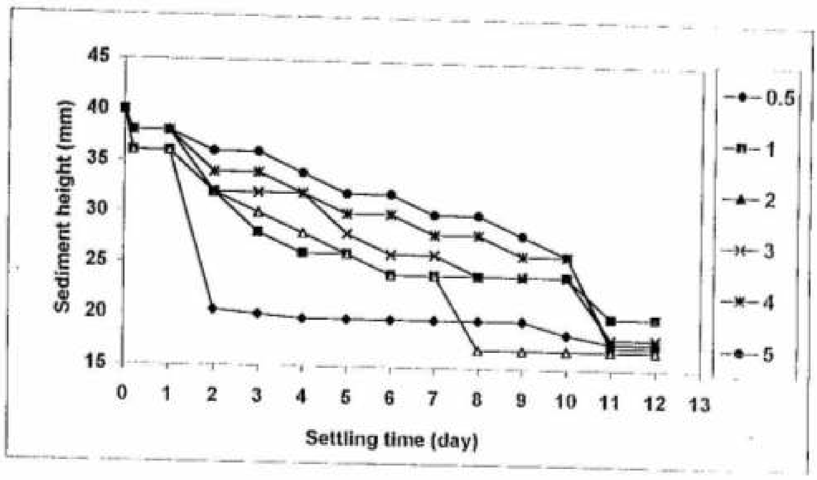

Figure (4): Sediment height of Merkhiat kaolin powders having particle size of (−63+53 µm) as a function of settling time in the presence of different wt% of Arabic gum.

One can easily distinguish between dispersions with the very fine particle size, i.e. (53+32 µm), long time was needed to achieve final settlement especially with high concentrations of Arabic gum (Fig. 5).

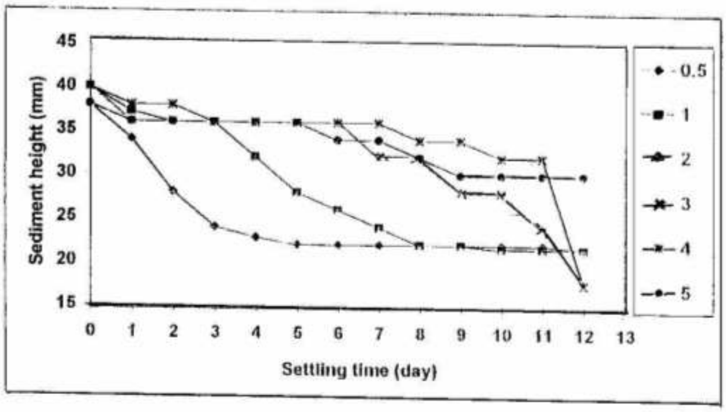

Figure (5): Sediment height of Merkhiat kaolin powders having particle size of (–53+32 μm) as a function of settling time in the presence of different wt% of Arabic gum.

In this case sedimentation is markedly slower and after some time three layers are distinguished, the compacted sediment at the bottom, a clear layer at the top and an intermediate cloudy layer of fine particles. This was not noticeable with dispersion of kaolin of higher particle size in their dispersions, (Figs. 2, 3 and 4).

From the results mentioned, one can conclude that decreasing the size of the particles influencs the dispersion stability in terms of sedimentation rate, although the dispersant is the same, providing the surface active sites density is kept the same. In general, dispersions which have finer particle size interval need longer settling time though the final packing densities are not necessarily better than the dispersion having grad I of particle size, i.e. –90+32 μm. This may be possibly due to increase in the tendency of particle settlement packing. This phenomenon is well known in ceramics beds prepared from mixes having different particle sizes [8]. The final packing volumes of compact beds were significantly higher than these obtained for other particle sizes, showing very much better packing of the particles, the results obtained are shown in Fig. (6).

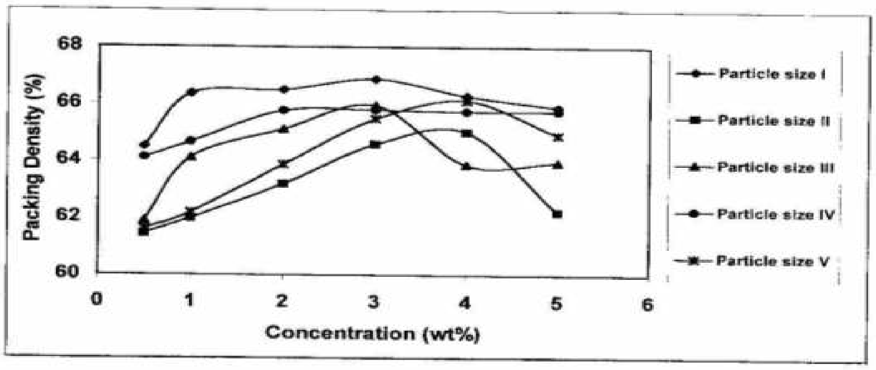

Figure (6): Final packing density of settled Merkhiat kaolin powder from different concentrations of Arabic gum as a function of the powder particle sizes.

It can be seen very clearly that the particle size of kaolin powder has a good influence on the measured packing density as it has on their settlement. Each particle size has its own effective dispersant's concentration, which appears in the form of a maximum value of packing density Fig. (6). Concentration of about 3 wt% Arabic gum was the average needed and particle size grade I, –90+32 μm, being the best.

Refernces

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