Short communication

Stability and phase separation behaviour of systems of particles in a medium with added polymer

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Abstract

The stability of barium carbonate ($BaCO_3$) suspensions in the presence of the dispersants, xanthan gum, sodium carboxymethylcellulose and carrageenan, has been studied using a phase separation technique. These materials have been found to stabilise the $BaCO_3$ suspensions by increasing the viscosity of the medium. Of the three polymer dispersants, xanthan gum is the most effective in stabilising and destabilising the suspensions. The experimental results are compared to the phase separation and stability of non-aqueous latex suspensions in the presence of non-adsorbing (free) polymers. The systems consist of poly (hydroxystearic) acid (PHS) coated poly(methylmethacrylate) (PMMA) particles in dodecane and well-characterized *cis*-poly(isoprene) (PIP) and poly(isobutylene) as the non-adsorbing added polymers.

Keywords: critical polymer concentration; depletion flocculation; dispersant; non-adsorbing polymer; phase separation; sedimentation; stability

Introduction

The interaction between colloidal particles is of paramount importance in industrial solid-liquid separation processes and is therefore one of the main topics in colloid science. In polar media, such as water, the interaction between colloids is often well described by the DLVO theory, which combines Van der Waals attraction between particles and repulsion due to overlap of the ion clouds surrounding the particles (Verwey and Overbeek, 1948). Although this theory successfully explains the stability of many colloidal systems, the existence of so-called non-DLVO forces plays a crucial role in a number of industrial colloidal formulations and processes. Colloids can also be sterically stabilized by chemically or physically attaching polymers to the particle surface (Israelachvili, 1992; Tadros, 1982). In good solvents or theta solvents for the polymer, colloids repel each other when overlap of their polymer layers forces the polymers into entropically unfavourable conformations.

It is well-known that the addition of soluble, non-adsorbing (free) polymer to a colloidal dispersion modifies the inter-particle interactions and hence the stability characteristics (Tadros, 1982). While the polymer as an adsorbed species may have a stabilising effect on the dispersion, the free polymer in solution has been shown to have the opposite effect in the semi-dilute regime. As the polymer concentration in the continuous phase increases, a critical polymer concentration is reached above which the free polymer is excluded from the inter-particle space. The exclusion of the polymer due to depletion or loss of configurational entropy results in attractive force, which is proportional to the osmotic pressure of the polymer in the bulk solution, between the particles. This attractive force results in particle dispersion instability referred to as depletion flocculation. The phenomenon of depletion flocculation is relevant to prevention of formation of dilatant sediments upon sedimentation.

The manufacture of building materials such as bricks, tiles and ceramics nearly always involves water-soluble of sulphates of calcium, magnesium, potassium and sodium. Portland cements, clay and sand used in the mortar and grout during construction are usually the sources of the water-soluble salts. In the case of brick manufacture, these sulphates may cause crystallisation and efflorescence on bricks (Loewenthal et al, 1986). In the efflorescence, many test programmes have been developed and numerous attempts have been made to eliminate the problems caused by water-soluble salts. Unfortunately, nothing has proven 100% effective against this stubborn problem.

Barium carbonate ($BaCO_3$) is a light coloured powder used as a chemical additive in brick- and glass-making. It is known to be effective at eliminating sulphates by reacting to form a precipitate, which can easily be removed (Trusler et al, 1991). In other words, $BaCO_3$ immobilizes the sulphates and renders them insoluble. This prevents the salts from being dissolved into solution that could migrate through the wall to the surface. Fine particles of carbonate are more effective, so it is usually applied in powder form with particle sizes ranging from 0.25 to 2 μm. However, this powder poses a significant health hazard and is also difficult to preserve and handle. A suspension of barium carbonate would be easier and safer to use; however, previously tested formulations have been unstable, settling or destabilising if left for a week or more.

In this paper, the effects of adding different dispersants in order to form a stable formulation of $BaCO_3$ suspension are considered. Dispersants are useful in preventing settling, deposition, precipitation, agglomeration or caking of solid particles in a fluid medium (Nussinovitch, 1997). Biopolymeric dispersants used in this study were xanthan gum, sodium carboxymethylcellulose (CMC) and carrageenan. Adding small amounts of the dispersant to an aqueous suspension can significantly increase its stability even in changing temperatures and after many months. Such stable suspensions could also prove useful for removing water-soluble sulphates in effluent treatment

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