COMPARATIVE STUDY OF DEFLOCCULATION IN KAOLIN SUSPENSIONS USING DIFFERENT SODIUM-BASED DEFLOCCULANTS

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1. INTRODUCTION

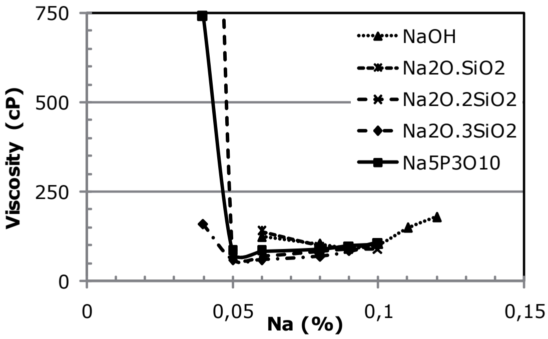
When wet-route, followed by spray-drying, is used to prepare the pressing powders, low viscosity and high solids content of the suspension are essential for ensuring enhanced energy efficiency. The use of deflocculants is inevitable if such suspensions are to be obtained. Deflocculants act on the clay particles in the suspension to provoke dispersion. Deflocculants work via three basic mechanisms: electrostatic, electrosteric and steric mechanisms. The first is related to the ion exchange of divalent cations (Ca^{++} and Mg^{++}) adsorbed on the clay surface with monovalent cations (normally Na^{+}). In the second mechanism, apart from ion exchange, the anionic part of the molecule is adsorbed on to the surface of the particles, causing them to repel each other. In both cases, the action of the deflocculants is most effective when, after precipitation, they remove the divalent cations from the solution. The degree of deflocculant efficiency depends very much on the type of clay: its mineralogy (kaolinite, illite, montmorillonite), particle size, pH, organic matter and adsorbed cations, as well as on the quality of the process water. Thus, a deflocculant cannot be assured to be equally effective for all clays used to produce ceramic tiles. A common and practical comparison of deflocculants is based on calculating the percentage doses to be used and their price per kilogram. However, such a comparative study does not differentiate between deflocculant concentrations or the cation concentration in each. Therefore, in order suitably to characterise the efficiency of different deflocculant substances, viscosity rates need to be standardised in terms of content or concentration of the active principle, in this case, the sodium cation.

2. EXPERIMENTAL PROCEDURE

Five different sodium-based inorganic deflocculants were analysed in this study: sodium hydroxide (NaOH), sodium metasilicate ($Na_2O.SiO_2$), sodium disilicate ($Na_2O.2SiO_2$), sodium trisilicate ($Na_2O.3SiO_2$) and sodium tripolyphosphate ($Na_5P_3O_{10}$). Solutions were prepared at 25% concentrations, except for tripolyphosphate, where the concentration was 10%, because of its solubility limit. The concentration of Na^{+} in all solutions was known. Beneficiated kaolin clay used for glaze preparation was used as raw material. Preliminary tests were carried out in order to devise a standard procedure for preparing deflocculation curves. The deflocculant solution was added to drinking water in pre-determined amounts. After one minute stirring, a suitable amount of kaolin was added to obtain the programmed suspended solids content (60, 63 and 65%); the mixture was stirred for a further 10 minutes before the viscosity was measured (Brookfield viscosity meter, 1 & 2 spindles, at 10 rpm) and the time taken for a nº 4 Ford cup (100 ml) to empty was determined. This procedure was repeated by preparing approximately 200 ml of suspension for each experimental point on the deflocculation curve. The density of the suspensions was measured using a 100 ml pycnometer as a way of controlling the procedure.

3. RESULTS AND CONCLUSIONS

The results shown in figure 1 indicate that the deflocculants $Na_5P_3O_{10}$, $Na_2O.3SiO_2$ and $Na_2O.2SiO_2$ are equally effective when the same quantity of sodium is added. For the deflocculants NaOH and $Na_2O.SiO_2$, almost twice the amount of sodium was required to produce the same deflocculating effect. These results indicate that the various anions precipitated the divalent cations in different ways. A possible order of effectiveness can be established, namely disilicate/trisilicate > tripolyphosphate > metasilicate > hydroxide. Both the disilicate and the trisilicate are equally effective as deflocculants. Nevertheless, for this system, the disilicate is considered to be more suitable as it requires a smaller total amount (including the anionic part of the molecule) and it is also commercially cheaper. Such a generalisation is not completely valid for ceramic glaze suspensions, since the degrading effect of the silicate on carboxymethylcellulose (CMC) needs to be taken into account. As the solids content is raised, a significant difference in the effectiveness of the deflocculants can be seen.



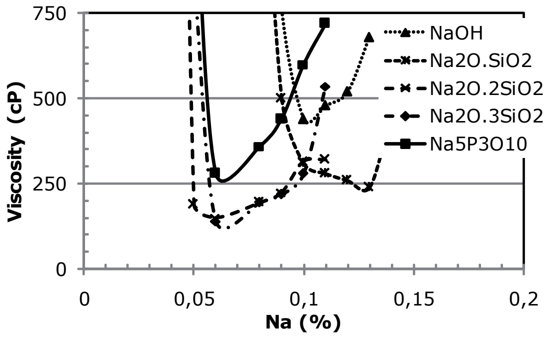


Figure 1. Deflocculation curves for the various deflocculants in suspensions with suspended solids contents of 60 and 63%. The respective densities and emptying times of a nº 4 Ford cup for each solids content tested were 1.58; 1.65g/cm³ and 27; 52s. At 65% solids content, similar trends were displayed but the minimum emptying time was 120s, which is unsuitable for industrial use of the solution.

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