

DEFLOCCULATION OF KAOLIN SUSPENSIONS – THE EFFECT OF VARIOUS ELECTROLYTES

V. PĚNKAVOVÁ^{1*}, M. GUERREIRO², J. TIHON¹, J. A. C. TEIXEIRA²

¹Department of Multiphase Reactors, Institute of Chemical Process Fundamentals AS CR,
Rozvojová 135, 165 02 Prague, Czech Republic

²Centre of Biological Engineering, University of Minho, Campus Gualtar, 4710-057, Braga, Portugal

*Corresponding author: penkavova@icpf.cas.cz

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ABSTRACT:

Viscosity reduction of aqueous kaolin suspensions by conventional additives (deflocculation) is studied, using standard viscosity measurements. Apparent viscosity at 100 s^{-1} , and flow behavior index n give complex information about changes of viscosity and flow character of deflocculated suspensions. Several widely used deflocculants – electrolytes and polyelectrolytes – are tested in a wide range of concentrations. The optimum concentrations of these deflocculants, which result in minimum apparent viscosity of suspension, are found. Sedimentation stability of deflocculated suspensions is monitored. Inorganic electrolytes are found to be more effective in viscosity reduction. On the other hand, low-molecular-weight polyelectrolytes produce more stable final suspensions.

KEY WORDS:

kaolin suspensions, deflocculants, viscosity measurements, stability of suspensions

1 INTRODUCTION

Reducing viscosity by addition of a small amount of suitable electrolyte is widely used for aqueous kaolin suspensions in ceramic, paper and dye industries to facilitate transport, agitation, and other mechanical operations. This process is called deflocculation, due to the assumed mechanism of the particle interactions in a liquefied suspension. Mineral kaolinite is a dominant compound of the kaolin clays. Kaolinite particles with their two-face layer structure (the octahedral alumina layer covered by hydroxyl groups and the tetrahedral silica layer with excreted oxygen [1, 2]) are susceptible to creating of hydrogen bonds and thus exhibit strong electrochemical interactions in aqueous media. This is the reason why a small addition of an electrolyte influences the finally achieved viscosity and stability of aqueous kaolin suspensions. Adsorption of chemical agents on different parts of kaolin structure (faces or edges) is strongly affected by pH value of the suspension.

The intensity of electrochemical interactions is manifested via zeta-potential. It gives information on the difference of potentials between the particles covered by electrical double layer and the surrounding medium. If zeta-potential is high, repulsion forces be-

tween particles are strong, interacting particles do not aggregate, and the prepared suspension is stable and low viscous. A lot of works deal with the measurement of zeta-potential of mineral suspensions in dependence on the content of additives and the actual value of pH [3–9]. The information obtained from zeta-potential measurement of kaolin suspensions is not easy to interpret because of the complex structural character of kaolinite (silica and alumina faces have different surface potentials [10]). The dominant particle interactions influence the internal structure and consequently also the rheological behavior of kaolin suspensions [3, 11]. The viscosity measurements, therefore, can provide fundamental information on the quality of suspensions. Changes in flow behavior of mineral suspensions caused by additives are usually described in the form of the dependence of yield stress on the content of additives and the actual value of pH [3, 4, 8, 9]. The yield stress is found to be inversely proportional to square of zeta-potential and directly proportional to a power of the volume fraction of solid particles in the suspension [3].

Only few works deal with detailed viscosity measurements of aqueous kaolin suspensions, see [12] for the primary suspensions and [13–20] for the suspensions with additives. Unfortunately, these works are

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our kaolin producer and works very well in our case. Probably the behavior of batch suspension can differ from pure kaolin suspension used in our work. Also different compositions and qualities of used kaolin minerals can play role (e.g. the specific surface area 26.9 and 18.6 m²/g is stated for Florida (USA) and Sedlec (Czech Republic) deposits, respectively). Also Vlasak et al. [20] have found slightly higher efficiency of WG than Na₂CO₃ (with apparent viscosities at 199 s⁻¹ two times smaller). As they used kaolin from the same deposit and producer (kaolin Sedlec Ia), a small discrepancy in the viscosity results suggests that also different batches of the same mineral can behave differently.

4 CONCLUSIONS

The efficiency of deflocculation by addition of various electrolytes to aqueous kaolin suspensions was tested via standard viscosity measurements. Variance of two parameters, apparent viscosity η_{100} and flow behavior index n , with an additive concentration c_{add} was used to give complex information about changes of viscosity and flow character of deflocculated suspensions. The independence of deflocculation effect on kaolin concentration was verified. For all three tested kaolin concentrations (30, 35, and 40 %) the range of additive concentrations, which led to lowest viscosities, was the same at the case of two tested additives (SHMP and NaOH). Decreasing of suspension viscosity using optimum deflocculant concentration is always connected with change of flow character from shear thinning toward to Newtonian. Addition of any inorganic electrolyte led to suspensions having seriously Newtonian character and the same level of viscosity less than 10 mPas, only different amount of additive was need. Using organic polyelectrolyte led to more consistent suspensions and both apparent viscosity and flow behavior index depended on molar mass of used NaCMC. An excess of deflocculant led to recovery of shear thinning behavior and increase of apparent viscosity in the case of inorganic electrolytes. This is extremely significant when NaOH is used. Qualitative observations of the stability of prepared suspensions were also made. The suspensions containing inorganic electrolytes was found not very stable, in the contrary organic polyelectrolytes produced more stable suspensions. In summary, inorganic electrolytes produce really low viscous, but not very stable suspensions, whereas organic polyelectrolytes produce more viscous, but rather stable suspensions. It depends on concrete technological process what should be preferred.

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