DISSOLUTION OF SMECTITE IN SYNTHETIC LUNG FLUIDS. ROLE OF ORGANIC LIGANDS AND BIODURABILITY

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The World Health Organization has identified smectites as having the potential to produce moderate fibrosis in the lungs following long-term exposure (1). Harmful effects may be dependent on the dissolution rate in lung fluids. The aim of this study is to determinate the smectite dissolution rates in saline solutions that mimic synthetic lung fluids (SLF) to gain knowledge about the residence time of the inhaled clay particles in the human body.

Dissolution rates of K-montmorillonite were measured in modified Gamble's solutions at pH 4 (macrophages) and 7.5 (interstitial fluids) at 37ÂºC in stirred flow-through reactors. The particle size, measured by transmission electron microscopy, was of 500 nm in diameter. The effect of organic acids was investigated through the addition of lactate, citrate and glycine (0.15, 1.5, 15 mmol L^{-1}).

The results showed that the addition of lactate or glycine does not markedly affect the montmorillonite dissolution rates at pH 4 irrespective of their concentration. However, at pH 7.5 there exists a slight inhibitory effect of lactate on the dissolution, probably due to a reduction in the number of reactive surface sites caused by lactate adsorption onto the montmorillonite surface. However, citrate enhances the dissolution rate by 0.5 orders of magnitude at pH 4 and more than one order of magnitude at pH 7.5, thus indicating the prevalence of the ligand-promoted over the proton-promoted dissolution mechanism under these experimental conditions. The enhancement of the dissolution rate in acidic citrate solution likely comes from the formation of surface complexes between the ligand and the edge surface of montmorillonite. In neutral conditions the effect may be also due to the decrease of the activity of Al^{+3} by formation of aqueous Al-Citrate complexes.

The kinetic data were used to estimate the reduction in size of an inhaled clay particle. At pH 7.5, a particle of 500 nm in diameter could be reduced 25% in presence of citrate whereas the reduction in saline solution would only be 10% after 10 years.

[1] WHO (2005) Bentonite, kaolin and selected minerals. Environmental Health Criteria 231, pp. 1-174.

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