



Electroacoustic Behaviour of Calcium Carbonate

Abstract

The normal devices for measuring particle size and zeta require very significant dilutions. These dilutions will alter the zeta potential unless the user is careful to preserve the ion concentration. However for some colloids, even the most careful dilution will alter zeta. In this article we describe one such colloid, calcium carbonate. These particles dissolve at low pH and this alters the ion concentration. It is simply impossible to dilute this colloid without changing the zeta potential. The *only* way to measure zeta in these systems is to use the ZetaProbe or AcoustoSizerII, which can measure at the working concentration.

Introduction

Colloidal calcium carbonate is widely used in industry. Slurries of CaCO_3 in water have a pH of about 9 and show a small positive zeta potential. Lowering the pH increases the zeta potential but the minimum accessible pH is about 7. Lower pHs cause the solid to begin to dissolve and this, together with the increasing buffering action of the HCO_3^- ion, makes it difficult to measure properties much below pH 7.

The calcium ion released as the pH is lowered causes hysteresis in the plot of zeta potential against pH, but the size does not change very much over the pH range from 7 to 10.

1 Examination of Calcium Carbonate

Calcium carbonate is widely used as a filler and modifier in industry and as a coating agent in, for example, paper making. It is a white, crystalline solid with low water solubility. It hydrolyses slightly to produce a pH above 7. The surface charge on the crystallites is positive under normal conditions, due to a slight preponderance of calcium ion. The magnitude of the surface charge is determined by the calcium ion concentration and the pH. It falls to zero at about pH 10 and is negative above that value.

We examined the electroacoustic behavior of a sample of calcium carbonate (10% by volume), first as a function of pH from its normal value of about 9.5 up to 10 and then down to about 6.8. The sample was then diluted in the apparatus to 5% and taken back up to pH about 10.

2 Results of Study

Figure 1 shows the result of the titration on the 10% calcium carbonate. At the initial pH of 9.25, the zeta potential is slightly positive, but adjustment to pH 10.1 takes the system through the *isoelectric point (iep)*.

As the pH is lowered the zeta potential becomes more positive. At pHs below 7 the system began to consume acid with no change in pH as the solid dissolved to produce HCO_3^- ions which buffer the solution to maintain a constant pH.

The suspension was then diluted to 5% with deionised water which produced a slight increase in the pH and an increase in zeta potential.

Further addition of acid lowered the pH only marginally and raised zeta slightly to a little over 11 mV. Raising the pH then caused zeta to fall slightly but there was a very large hysteresis in the system, for the zeta remained much more positive as the pH was raised.

This zeta is more positive on the return leg because the solution now contains a considerable amount of calcium ion, which is preferentially adsorbed on the surface of the solid and renders that surface more positive. It therefore raises the i_{ep} to higher pH values, since it now takes more hydroxide ions to convert the surface to a negative value.

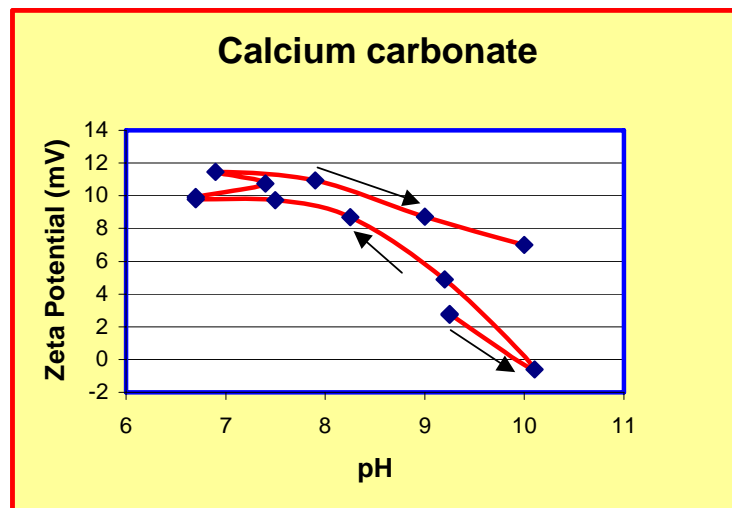


FIGURE 1 TITRATION OF CALCIUM CARBONATE.

Thus the zeta potential for this system depends on the history of the titration and it is clearly sensitive to any dilutions. This material *must* be measured at the working concentration to determine the true zeta potential.