Isoelectric Point (IEP) Determination

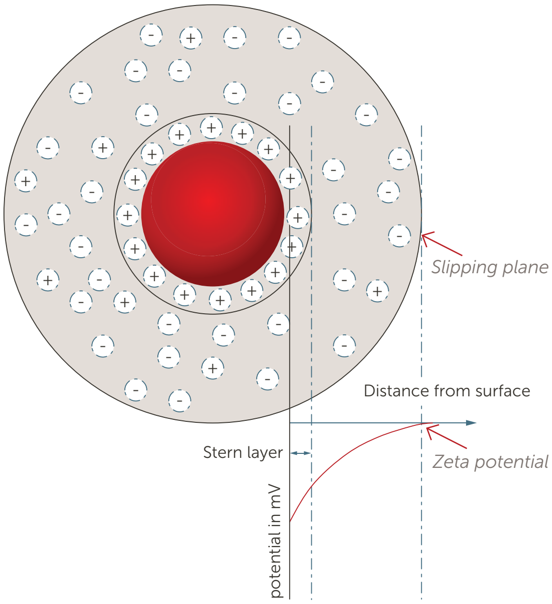
Nicomp® ZLS

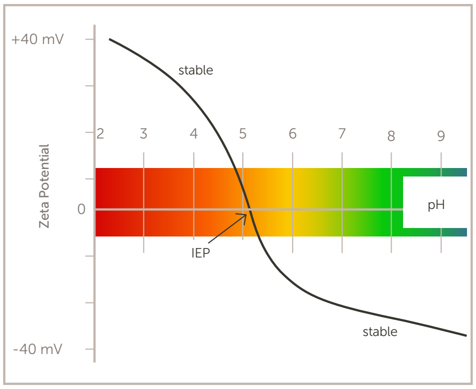
The isoelctric point (IEP) of a dispersion is the pH value at which the zeta potential equals zero. It is a common reason to make zeta potential measurements because the IEP indicates the surface chemistry conditions that may cause dispersion instability. The IEP is also used to determine the surface properties of engineered particles.

Dispersions with a high zeta potential, typically > positive or negative 30 mV, tend to be more stable with time so zeta potential is often used to predict dispersion stability. Adjusting the pH of a dispersion is one easy way to change the zeta potential, and therefore stability of a dispersion.

ZETA POTENTIAL

Particles within a colloidal dispersion carry charges that can effect the stability of the suspension. Close to the surface each particle is surrounded by oppositely charged ions in what is called a fixed, or stern layer. Beyond the stern layer there are both positive and negative ions in what can be considered a charge "cloud" that is more diffuse but still move with the particle. The notional distance from the surface of the particle that separates the ions in equilibrium, from the double layer of ions that move with the particle, is known as the slipping, or shear plane. The zeta potential (ζ) is defined at the electric potential measured in mV at the slipping plane.





ISOELECTRIC POINT

The pH value where the zeta potential equals zero is known as the isoelectric point (IEP). One reason to measure the IEP is to determine the conditions where the dispersion is likely to be very unstable. Another reason is to determine which chemical species is present at the surface of an engineered particle, because zeta potential is specific to surface properties only. For example, the IEP of a silica particle coated with alumina will be the IEP of alumina. Some reference IEP values are shown in Table 1.

Alpha aluminum oxide	8 – 9
Alpha iron oxide	8.5
Cerium oxide	7 – 8
Chormium oxide	6 – 8
Iron oxide (magnetite)	6.5
Magnesium oxide	12 – 13
Manganese oxide	4 – 5
Nickel oxide	10 – 11
Silicon carbide	2 – 3
Silicon dioxide	2 – 3
Silicon nitride	6 – 7
Tin oxide	4 – 5
Tungsten oxide	0.5
Zinc oxide	9 – 10

Table 1. Example IEP values

IEP OF ZETA REFERENCE STANDARD

Entegris' zeta reference standard (ZRS) has a very reproducible IEP value. The ZRS is basically an oil in water emulsion stabilized using mono- and diglycerides that act as an emulsifier.

Sample preparation: 0.1 g of powder was dissolved in 200 mL of DI water (pH 6.7) by stirring for three minutes. This beaker was then continuously stirred during the entire experiment with a pH probe immersed in the sample. A 0.1 N solution of HCl was prepared to titrate the sample from pH 6.7 to 3.5.

Measurement procedure: About 3 mL of sample was placed in a disposable cell. The Nicomp® electrodes were inserted into the cell. The measurement settings are shown in Figure 1. Three, 60 second measurements were performed at each pH value and the average zeta potential value was calculated. After each measurement, the dip cell electrodes were flushed with DI water and the pH was lowered for the next measurement.

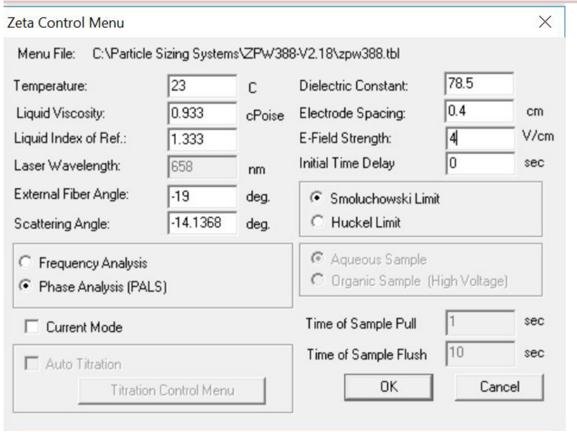


Figure 1. Zeta potential measurement settings

The results after taking zeta potential measurements at seven pH values are shown in Figure 2.

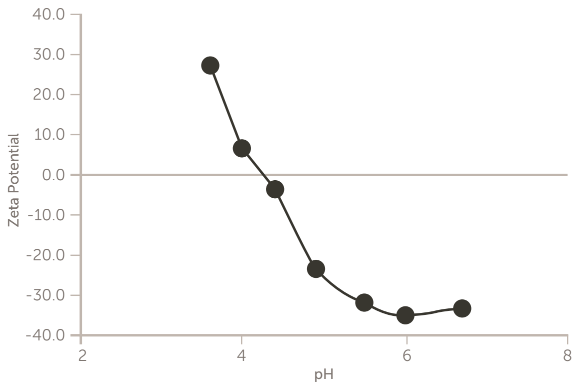


Figure 2. IEP data for non dairy creamer

In this study the IEP = 4.2, the pH value where the zeta potential = 0 mV.

IEP OF PROTEINS

Sample preparation and measurement procedure: Ampoules of bovine serum albumin (BSA) were diluted 1:100 with DI water. This BSA solution was brought to pH 8 with 0.1 M KOH and titrated with 0.01 M HCl to a final pH of 3.75. Three zeta potential measurements were taken at each pH value and the average was calculated.

Figure 3 shows the volume weighted mean particle diameter to be 5.5 nm. Figure 4 shows the IEP titration data, where the IEP = 5.07.

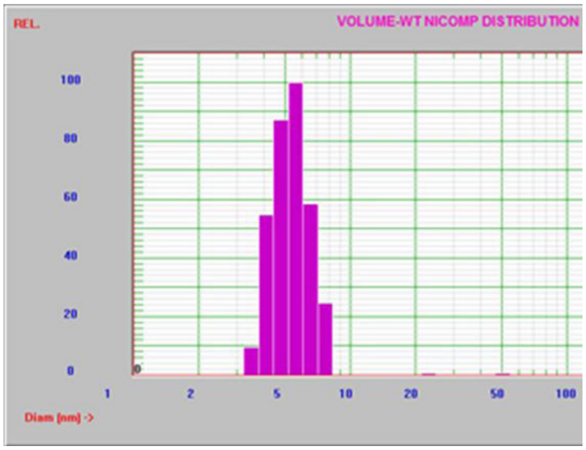


Figure 3. Particle size of BSA protein-volume weighted

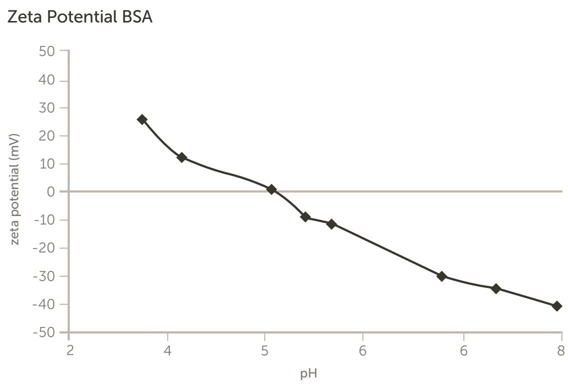


Figure 4. IEP data for BSA protein

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