Edta titrations essay sample

Complexation Reaction: A reaction between two species having a well-defined stoichiometry. The resulting bond is not permanent from a covalent standpoint. Complex: The resulting structure formed during a complexation reaction. Coordination Center: Metal ion in a complex (Lewis acid) Ligand: The species that complexes the metal center. A single species can form one or more bonds with a single coordination center (Lewis base) Coordination Number: Number of ligand bonds formed around the coordination center. Chelate: Ligands that form multiple bonds (multidentate; bi, tri, tetra, penta)

Ethylenediaminetetraacetic acid EDTA CO 2

CO2NH+ CO2-

NH+ CO2-

Ethylenediamine

NH2+

NH2+

• EDTA is the most commonly used chelating agents as it can form complexes with a wide range of metals. • The ability of EDTA to complex is dependent on its form. The most desirable state is the Y4- form. • As the pH increases, more EDTA becomes Y4-. [Y 4-] = [H 6 Y 2+] + [H5Y +] + [H 4 Y] + [H 3 Y –] + [H 2 Y 2-] + [H Y 3-] + [Y 4-] a Y 4[Y 4-] = [EDTA]

Equil. Concentrations

• The formation constant for metal-EDTA complexes is:

M n + + Y 4- = MY n – 4 [MY n – 4] Kf = [M n +][Y 4-]

• It is important to note the requirement for the charge state of EDTA. Leads to a conditional (effective) formation constant

[MY] K ‘ f = a Y 4 – K f = n+ [M][EDTA]

n -4

Equilibrium Concentrations

• Again we must consider equilibrium reactions and concentrations in analysis using complexation. • Equilibrium constants are referred to as formation constants, Kf. • For simple complexes (1: 1) we can make some similar assumptions and generate similar equations as we did for monoprotic acids • For more complex systems we must deal with step-wise formations and step-wise formation constants.

EDTA titrations

1. Before the equivalence point there is excess M in solution At the equivalence point, treated as dissolving pure MY complex. After equivalence there is excess EDTA

Indicators

• The most common indicator is the metal ion indicator

– To be useful must bind less strongly than EDTA

– The most common indicator is Eriochrome black T. EBT binds to metal ions to give a red color. Upon release of the metal to EDTA, it becomes blue

• Can use ion specific electrodes and/or mercury electrodes. Both of these are more expensive and time consuming.

Sometimes there is not a strong reaction between EBT and the metal. This can be overcome by a displacement titration. The solution begins with the Mg2+ complexed with EDTA. The analyte is added (assuming higher binding constant and lower concentration) and the Mg2+ is displaced. The Mg2+ is titrated with EBT. A second way to overcome titrations with weak end points is to do a back titration. In a back titration, excess EDTA is added to the sample solution. The excess is then titrated with a standard Mg or Zn solution.

EDTA is a widely applicable complexing agent as it will complex with almost any metal. This can be a problem if selectivity is desired however. Selectivity can be controlled through pH.

A second method for adding selectivity is to add a competing reagent called a masking agent. A masking reagent reacts with one of the species and allows titration of the second. This can be applied to a simple binary mixture or to a more complex mixture. For example, if NH3 is used as a buffer, Cd2+ can be titrated in the presence of Zn2+.