EDTA titration of Calcium and Magnesium cations in Seawater

Lab report 3

3/29/2010

Chem 216

# Purpose:

Calculation of the concentration of ca2+ and mg2+ ions using complexiometric titrations with EDTA and erichrome indicator for the complexation of both cations with EDTA. We use calcon indicator for the second complexation of ca2+ with EDTA.

# Procedure:

Refer to the lab manual. However, we do not weigh the EDTA using a preweighed 150ml beaker and recording the mass. We weight the vile containg the EDTA and then subtract the weight of the empty vile after transfering the EDTA crystals to the beaker. The difference of the two is the weight of the EDTA.

# Data:

|  |  |  |  |
| --- | --- | --- | --- |
| Mass of EDTA + vile (g)  | Mass of empty vile (g) | Mass of EDTA | Moles of EDTA (mol) |
| 17.8805 g | 17.5702 | 0.3103 | 3.334$×10^{-3}$ |

|  |  |  |  |
| --- | --- | --- | --- |
|  | Volumes of EDTA using erichrome indicator.(titration1) | Volume of EDTA of titration 2 (using calcon indicator) | Volume of EDTA of blank solution: |
| Trial 1 | 22.3 | 3.20 | 0[[1]](#footnote-1) |
| Trial 2 | 22.5 | 3.20 |  |
| Trial 3 | 22.0 | 3.30 |  |
| Average | 22.3 | 3.23 |  |
| Standard deviation | 0.14 | 0.07 |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | [Ca 2+ + Mg2+](mol/l) | [Ca 2+] (mol/l) | [Mg 2+](mol/l)  |
| Trial 1 | 0.0743 | 0.0107 | 0.0636  |
| Trial 2 | 0.0750 | 0.0106 | 0.0643 |
| Trial 3 | 0.0733 | 0.0110 | 0.0633 |
| Average | 0.0742 | 0.0108 | 0.0637 |
| Standard deviation: | 0.0009 | 0.0002 | 0.0005 |

|  |  |  |  |
| --- | --- | --- | --- |
|  | [Mg 2+](ppm)  | [Ca 2+] (ppm) | [Ca 2+ + Mg2+](ppm) |
| Trial 1 | 1546 | 429 | 1975 |
| Trial 2 | 1563 | 425 | 1988 |
| Trial 3 | 1539 | 441 | 1980 |
| Average | 1550 | 432 | 1981 |

## Observations:

* In the first set of titrations, we use the erichrome indicator to indicate the endpoint.

MgIn + EDTA MgEDTA + In

Red Colorless Blue Colorless

Hence, the color change observed is from wine red to an intermediate purple color and finally blue indicating the endpoint.

* In the second set of titrations, we use the calcon indicator to indicate the endpoint after precipitating the magnesium cations, leaving the calcium ions.

CaIn + EDTA CaEDTA + In

Red Colorless Blue Colorless

As in the previous set of titrations, the color change observed is from wine red to blue.

# Calculations:

* Mass of EDTA = Mass of EDTA + vile - Mass of empty vile

 = 17.8805g - 17.5702g

 = 0.3103 g

* The number of moles of EDTA: n (mol) = $\frac{m(g)}{MW (\frac{g}{mol})}$ = $\frac{0.3103 g}{372.24 g/mol}$ = $8.336 ×10^{-4} mol$.
* The concentration of EDTA in the 250 mL Volumetric flask:

[EDTA] (mol/l) = $\frac{n(mol)}{V (L)}= \frac{8.336 ×10^{-4} mol}{0.250 L}=3.334 × 10^{-3} mol/l$

For titration 1:

* Mean volume: Vav = $\frac{V1+V2+V3}{3}= \frac{22.5+22.3+22.0}{3}=22.3 mL$
* Standard deviation: s = $\sqrt{\frac{\sum\_{}^{}( Vi-Vav)^{2}}{n-1}}$ = 0.1

Similarly we calculate the mean volume and standard deviation of the second titration.

Trial 1:

* At the equivalence point of the first titration:

The number of moles of Calium and magnesium cations = the number of moles of EDTA added

n (Ca 2+ + Mg 2+) = n (EDTA)

[Ca 2+ + Mg 2+](mol/l) . V seawater(ml) = [EDTA] (mol/l) . Veq (ml)

[Ca 2+ + Mg 2+](mol/l) = $\frac{[EDTA] (mol/l) . Veq (ml)}{V seawater(ml) }=\frac{3.334 × 10^{-3}\frac{mol}{l}×22.3 ml }{1 ml}=0.0743 M $

* At the equivalence point of the second titration:

The number of moles of Calium cations = the number of moles of EDTA added

n(Ca 2+) mol = n (EDTA) mol

[Ca 2+] (mol/l) . V seawater(ml) = [EDTA] (mol/l) . Veq (ml)

[Ca 2+] = $\frac{[EDTA] (mol/l) . Veq (ml)}{V seawater(ml) }=\frac{3.334 × 10^{-3}\frac{mol}{l}×3.2 ml }{1 ml}0.0107 M $

* [Mg 2+](mol/l) = [Ca 2+ + Mg 2+](mol/l) - [Ca 2+] (mol/l)

 = 0.0743 M - 0.0107 M

 = 0.0636 M

Average of the concentration of both cations: Cav = $\frac{C1+C2+C3}{3}=0.07432 M $

Standard deviation of the concentration of both cations: s = $\sqrt{\frac{\sum\_{}^{}( Ci-Cav)^{2}}{n-1}}=0.0009$

* In ppm,

Trial 1:

* [Mg 2+] = $\frac{0.0636 mol}{l} ×\frac{24.305 ×10^{3}mg}{mol}=1546\frac{mg}{l}= \frac{1546 g of Mg}{10^{3}.10^{3}l}=1546ppm$ since water is the solvent and the density of water is approximately 1mg/l.
* Similarly: In ppm, [Ca 2+] = $\frac{0.0107 mol}{l}×\frac{40.078 × 10^{3 }mg}{mol}$ = 429 ppm
* The total concentration in ppm is [Mg 2+] + [Ca 2+] = 1975 ppm

Similarly we get the concentrations in the other trials, and we get the average values as above.

# Results

* In summary, [Mg 2+] = $1550ppm$
* [Ca 2+] = 432 ppm
* Therefore, the total concentration is 1550 + 432 = 1981 ppm
* For concentrations in Molar and further data refer to tables in the Data section.

# Conclusion

* A very common error is the inability to properly identify the equivalence point since the endpoint that we record is when the color changes from an intermediate purple color to a blue color indicating the complete complexation with EDTA. It is difficult to identify the drop where the color changes from purple to blue and thus it is easy to overshoot the endpoint.
* A hardness of about 2000 ppm is very large for house-hold use and at high temperatures could damage pipes and washing machines by forming sedimentations that eventually render them inactive. Therefore, in order to efficiently use sea water in house-holds, we must treat the seawater by precipitating the cations.
1. The erichrome indicator gave a blue color upon its addition to the distilled water, hence indicating the absence of any calcium or magnesium ions in the distilled water that could interfere with the analyte. [↑](#footnote-ref-1)