



Solubility Product Constant of Silver Acetate

(2016/03/10 revised)

Collect:

- Magnetic stirring bar (given out and collected by assistant TA)
- 25 mL Buret
- 125 mL Erlenmeyer flask (4)
- 10 mL graduated pipet
- Pipet filler
- Iron ring (1), Styrofoam cup (1), latex gloves

Prepare and oven dry:

- Funnels (2)
- 100 mL Beaker (4)



Objective and Technique

- ◆ Determine the solubility product constant (K_{sp}) of silver acetate at different temperatures
- ◆ K_{sp}
 - ◆ K_{sp} is constant for an insoluble salt at a given temperature
 - ◆ K_{sp} is independent of the concentration of ions or pH value of the solution, but changes with temperature
- ◆ Technique
 - ◆ Hot plate/magnetic stirrer
 - ◆ Dispenser
 - ◆ Gravity filtration
 - ◆ Graduated pipet
 - ◆ Titration

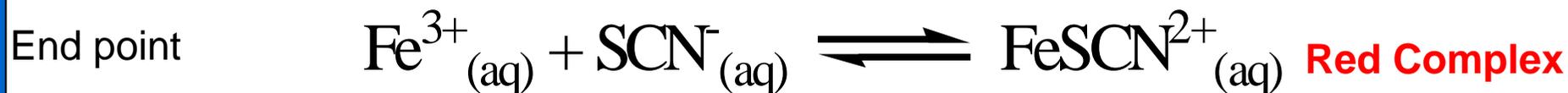


Introduction

- ◆ Titrate to determine the concentration of Ag^+ in the saturated solution and calculate the concentration of OAc^- to determine K_{sp}
- ◆ Investigate the effects of temperature on K_{sp}

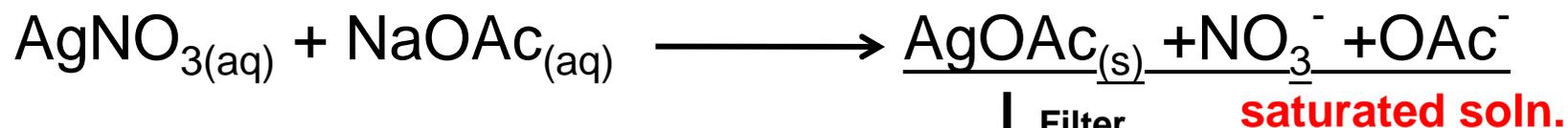


$$K_{\text{sp}} = [\text{Ag}^+][\text{OAc}^-]$$



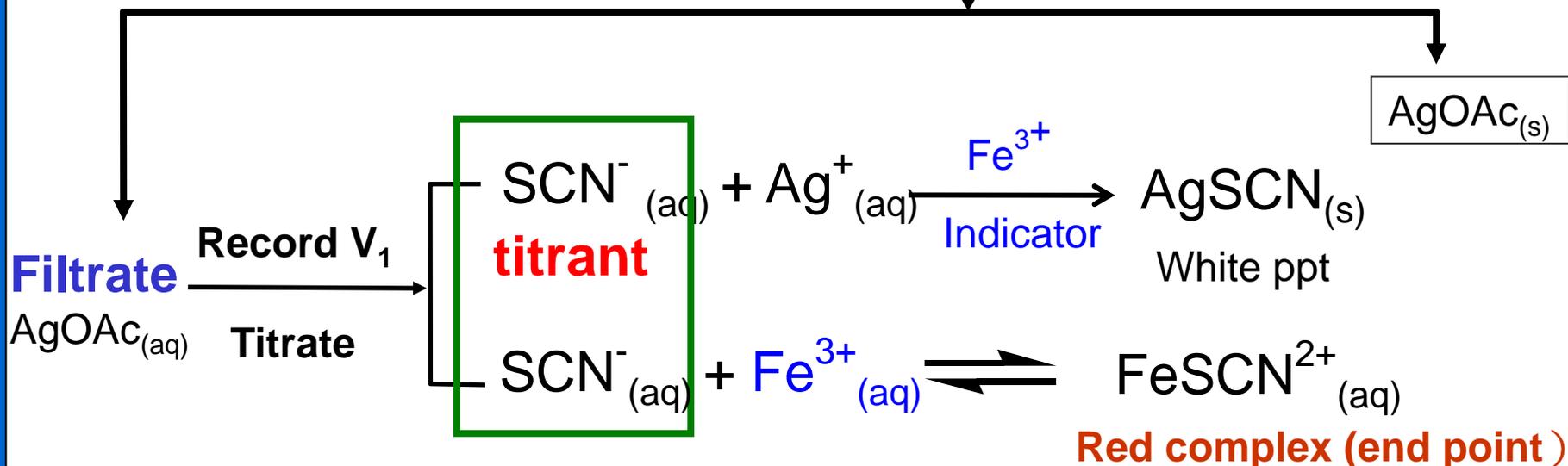


Concentration of $[Ag^+]$



Filter

$AgOAc_{(s)}$



Volhard method:

Ag^+ mol = SCN^- mol at the equivalence point:

$$[Ag^+]V_1 = [SCN^-]V_2, \text{ to get } [Ag^+]$$



Concentration of $[OAc^-]$

(1) Precipitation reaction



Before mixing $10.0 \text{ mL} \times 0.20 \text{ M} = 2.0 \text{ mmol}$ $5.0 \text{ mL} \times 0.30 \text{ M (excess)} = 4.5 \text{ mmol}$

After mixing $2.0 - 2.0 = 0 \text{ mmol}$ $4.5 - 2.0 = 2.5 \text{ mmol}$ 2 mmol
Ppt occurs

Total volume $10.0 + 15.0 = 25.0 \text{ mL}$

$$[OAc^-] = \frac{2.5 \text{ mmol}}{25.0 \text{ mL}} = 0.10 \text{ M}$$



Calculating the Value of K_{sp}

(2) Dissolution equilibrium



Concentration before
Equilibrium

0 M

0.10 M

Concentration after
Dissolution equilibrium

x M

(0.10 + x) M

$$K_{sp} = [\text{Ag}^+][\text{OAc}^-] = x(0.10 + x)$$



Procedure I: Prepare Saturated Silver Acetate Solution

Clean and dry a 100 mL beaker



Take 10.0 mL 0.20 M AgNO_3 and 15.0 mL 0.30 M NaOAc



Mix and stir 20 min
Record the temp. of soln



Gravity filtration to get AgOAc saturated soln



Transfer to Erlenmeyer flask

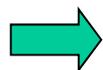


Add 1 mL Fe^{3+} indicator



Procedure II: Set Up Buret

Use a clean and dry
100 mL beaker

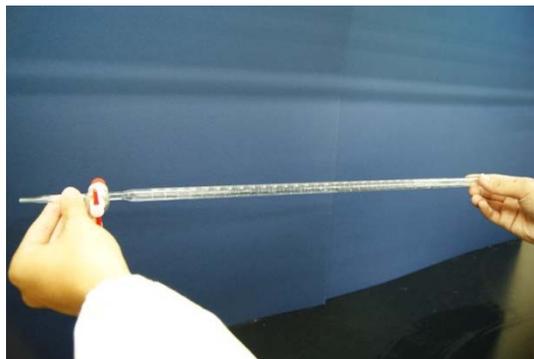


Take ca. **30 mL of**
0.050 M KSCN(aq)



Take no more than
30 mL KSCN(aq) to
reduce the waste

Rinse the buret with
~5 mL KSCN twice



Record V_i
to 0.01 mL

Free the tip of air
bubbles

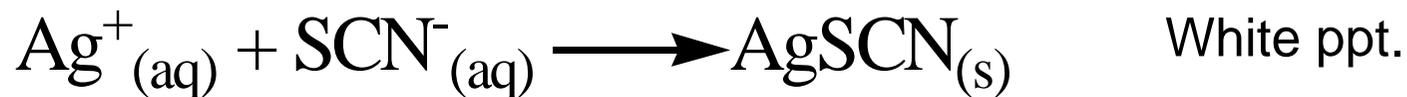


Procedure III: Titrate

- Titrate with KSCN(aq)
- Place buret tip well inside the flask
- To the end point, the soln appears light orange color
- Record V_f to 0.01 mL



◆ Titrating process:



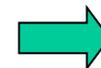
- ◆ Repeat steps above with another 10.0 mL of AgOAc(aq)



Procedure IV: K_{sp} at Low Temperature

Make another portion of $\text{AgOAc}(\text{aq})$ from 10.0 mL 0.20 M AgNO_3 & 15.0 mL 0.30 M NaOAc

- Stir and mix the soln in ice-water bath for 20 min
- Take the temp. of soln



Filter out the ppt. to get saturated AgOAc soln quickly to keep the low temp of mixture

Measure out 5.0 and 10.0 mL of saturated soln into flasks

Titrate to the end point



Notice

- ◆ Silver nitrate and sodium acetate should be obtained from the dispenser into a clean and dry beaker
- ◆ Buret and pipet should be rinsed with the test solution to prevent the solution from being diluted
- ◆ KSCN should be obtained by a beaker and limited to **30 mL**, only take more if it isn't enough
- ◆ The Fe^{3+} indicator should be obtained about **1 mL**, not one drop
- ◆ Temp. of silver acetate soln should be **recorded first**, then filtrated
- ◆ Avoid getting silver acetate on clothes or skin (gloves can be worn)
- ◆ Use tweezers to pick up filter paper after filtration, do not use your hands



Notice

- ◆ Waste liquids and precipitates contain heavy metal Ag, should be collected and discarded into designated recycling bins
- ◆ Buret and measuring pipet need to be clean and clamped inversely on the ring stand after class
- ◆ Wash the Erlenmeyer flasks with brush and detergent
- ◆ **Care should be taken not to discard the magnetic stirring bar** into the liquid waste bin or sink
- ◆ Return magnetic stirring bar to the TA to be counted



Example of Experimental Data

Test item		Room temp. (ex. 24.0 °C)		Ice bath (ex. 3.5 °C)	
		Rough titration	Accurate titration	Rough titration	Accurate titration
Volume of saturated AgOAc (mL)		5.00	10.00	5.00	10.00
0.050 M KSCN	V_i (mL)	1.70	5.50	4.17	6.40
	V_f (mL)	5.50	13.50	6.40	11.03
Titration volume	ΔV (mL)	3.80	8.00	2.23	4.63



Calculation: $N_1V_1 = N_2V_2$ to Obtain $[Ag^+]$

Temp.	(1) 24.0 °C	(2) 3.5 °C
$[Ag^+]$	$[Ag^+] \times 10.0 = 0.050 \times 8.00$ $[Ag^+] = 0.040 \text{ M}$	0.023 M
$[OAc^-]$	$0.10 \text{ M} + 0.040 \text{ M} = 0.14 \text{ M}$	0.12 M
K_{sp}	$0.040 \times 0.14 = 5.6 \times 10^{-3}$	2.8×10^{-3}