### Determination of Iron in Ore by Redox Titration

Oxidation-reduction reactions are suitable for titration reactions if they are rapid and quantitative. The end point can be seen by indicators or by instrumental methods such as potentiometry.

#### Potentiometric Titration of Ferrous Ion

The reaction of ferrous ion with ceric ion meets the above requirements.

The course of the titration may be followed potentiometrically with a platinum electrode. The following cell may be used:

Pt | Titration mixture of Fe3+, Fe3+, Ce4+, Ce3+ | SCE

The potential of the Pt electrode must obey the Nernst equation since the half reactions between Fe<sup>3+</sup> and Fe<sup>2+</sup> and between Ce<sup>4+</sup> and Ce<sup>3+</sup> are nearly reversible.

$$E_{p_1} = E^0(\text{Fe}^{3+}, \text{Fe}^{3+}) + 0.5916 \log \left[ \frac{[\text{Fe}^{3+}]}{[\text{Fe}^{2+}]} \right] = E^0(\text{Ce}^{4+}, \text{Ce}^{3+}) + 0.05916 \log \left[ \frac{[\text{Ce}^{4+}]}{[\text{Ce}^{3+}]} \right]$$
(2)

Equation 2 states that the Pt electrode can have only one potential, and the ratios of [Fe<sup>3+</sup>]/[Fe<sup>2+</sup>] and [Ce<sup>4+</sup>]/[Ce<sup>3+</sup>] must be such that the Nernst equation is satisfied for both half reactions. Reaction 1 will occur spontaneously to such an extent that equation 2 will be true. The ratios [Fe<sup>3+</sup>]/[Fe<sup>2+</sup>] and [Ce<sup>4+</sup>]/[Ce<sup>3+</sup>] change greatly at the equivalence point. The equivalence point is determined from the break in the titration curve.

#### Indicator Titration of Ferrous Ion

Specific indicators and true exidation-reduction indicators are available for redex titrations. Specific indicators are substances that react with one or more of the participants in a titration to produce a color change. A classic example is starch that forms a dark blue complex with I<sub>2</sub>. In redex titrations with I<sub>2</sub> as the titrant, blue color develops to mark the end point of the reaction when I<sub>2</sub> begins to accumulate in the solution. Thiocyanate is an indicator that forms a red complex with Fe<sup>3+</sup> but not with Fe<sup>2+</sup>, and thus can be used to indicate the formation or disappearance of Fe<sup>3+</sup>. Sometimes a redex reagent itself is deeply colored and can be used to indicate the end point. For example, MnO<sub>4</sub> is a purple ion often used as an exidizing agent. The first trace of purple color indicates that the MnO<sub>4</sub> is no longer being reduced by the titration reaction.

A true oxidation-reduction indicator is a substance that has different colors when in different oxidation states.

$$\ln_{ex} + n e - \ln_{ret}$$
 (3)

# **Determination Of Iron In Ore By Redox Titration Chemistry**

Harry G. Hajian, Robert L. Pecsok

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