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Development of Ce IV and Mn II Oscillometry: A New Estimation Method Based on Peak Potential and Oscillation Period of Chemical Oscillations

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Abstract

The linear relationship of oscillator concentration and oscillation characteristic (peak potential or oscillation period) in the bromate / oscillator / acetylacetone system of Belousov-Zhabotinsky chemical oscillations was examined and used as a basis for a new novel method for estimation of Ce IV and Mn II cation oscillators. The oscillation period (tos) based version was termed 'tos oscillometry' and the peak potential (pp) based version was called 'pp oscillometry'.

Keywords: Cation estimation method, Ce IV and Mn II, oscillators, bromate, acetylacetone, chemical oscillation, Belousov - Zhabotinsky systems, peak potentials, oscillation characteristics, oscillation period.

1. Introduction

The main objective of this work was to demonstrate the possibility of using peak potential (pp) and oscillation period (tos) values that accompany chemical oscillations for estimation of cations, such as Ce (IV) and Mn (II), which can act as oscillators. It is a novel alternative analytical estimation method.

Belousov-Zhabotinsky oscillations are the most popular of the chemical oscillation systems. They consist of bromate, an organic component containing an active methylene group such as acetylacetone, and an oscillator which flip-flops or oscillate between the reduced state [example Ce (III)] and oxidized state [example Ce (IV)].

Ce (IV), Mn (II) and Fe (phen)$_3^{2+}$ (Ferroin) are some commonly used oscillators (Win and Win 1985). Continuous alternate oxidation and reduction, caused by the following two reactions occurring repeatedly in turn, one after the other, result in oscillations, as shown in the rough diagram below.

Oxidized Oscillator ⇔ Reduced Oscillator

Ce (IV) ⇔ Ce (III)

Mn (VII) ⇔ Mn (II)

Fe (phen)$_3^{3+}$ ⇔ Fe (phen)$_3^{2+}$

(a) Bromate acting on reduced oscillator producing the oxidized oscillator (Oxidation).

(b) Acetylacetone acting on oxidized oscillator producing the reduced oscillator (Reduction).

The above rough diagram shows only the end states and serves to visualize the main part (the oscillation part) of chemical oscillations, and is therefore not a reaction mechanism scheme. The actual reaction mechanism is complex. The use of oscillation characteristics in cation estimation, rather than the study of the chemical oscillation process itself, is the goal of this study. Hence, elucidation of reaction mechanism is not contemplated in this study.

Chemical oscillations are accompanied by potential changes, which may be followed

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