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A detailed spectrophotometric investigation of the complexation of palladium(II) with chloride and bromide

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Abstract

As the speciation of metal species, especially the noble metals, are crucial for recovery and separation purposes, the complex formation of Pd(II), with chloride and bromide respectively, has been investigated employing spectrophotometry at 25 °C and an ionic strength of 1.0 M Hyperquad Simulation and Speciation (HySS) was employed to determine the ideal titration conditions and an autotitrator (equipped with a flow-through cell) was used to accurately vary the chloride and bromide concentrations over an increased number of intervals, i.e. 128 and 300 respectively. All of these data points were used to calculate the formation constants of both palladium systems employing HypSpec (software specifically developed for the determination of equilibrium constants from spectrophotometric data). The formation constants, β_n, for the palladium(II)-chloride and -bromide complexes, have been determined. For $[PdCl_n(H_2O)_{4-n}]^{2-n}$ (n = 0 – 4), the log β values are: log β_1 = 4.49, log β_2 = 7.80, log β_3 = 10.18 and log β_4 = 11.54, while the log β values for $[PdBr_n(H_2O)_{4-n}]^{2-n}$ (n = 0 – 4), are: log β_1 = 5.04, log β_2 = 9.12, log β_3 = 12.38 and log β_4 = 14.55. The formation constants for the palladium-chloride complexes agree well with the published data, while the formation constants for the bromide complexes differ from somewhat from published data suggesting a different, but more accurate speciation. Molar absorption spectra for all the complexes in question have been obtained. Pourbaix diagrams were constructed from the new speciation data showing the predominant species for each system.

Keywords: palladium(II), bromide, chloride, formation constants, spectrophotometry

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1 Introduction

Due to the excellent catalytic properties of the platinum group metals (PGMs), especially platinum, palladium and ruthenium, they are ideally suited for various applications that include fuel cell technology, industrial catalysts and catalytic converters, with the added benefit that they can be recycled [1-4]. Hydrometallurgical processes play a significant part in the processing, refining and