ELECTRODE POTENTIALS OF METALS AND THEIR ELECTROCHEMICAL CHARACTERISTICS

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Abstract

This article explores the nature and formation of electrode potentials of metals based on A.V. Pisarzhevsky's theory. The interaction between metal surfaces and electrolyte solutions is examined to understand the formation of electric double layers and potential differences. Special emphasis is placed on the standard electrode potentials of zinc and copper and the significance of ionization energy, hydration energy, and partial pressure in determining electrochemical activity. Furthermore, the concept of gas electrodes and the derivation of the Nernst equation are discussed, which are critical in evaluating the behavior of metals in electrochemical cells.

Keywords: electrode potential, metal ionization, standard hydrogen electrode, Nernst equation, electrochemical activity, galvanic cell

Introduction

Electrode potential is a key concept in electrochemistry, reflecting the tendency of a metal to lose or gain electrons when immersed in its salt solution. According to A.V. Pisarzhevsky’s theory, when a metal is immersed in water or its own salt solution, a potential difference arises at the metal-liquid interface due to the formation of an electric double layer.

Materials and Methods

To determine the standard electrode potentials of metals, galvanic cells were constructed using the standard hydrogen electrode (SHE) as a reference. The experimental setup included a platinum electrode in a 1 M H_2SO_4 solution with hydrogen gas at 1 atm, and a comparative metal electrode immersed in its 1 M salt solution. Electromotive force (EMF) measurements were taken using a high-precision voltmeter.

Results and Discussion

When zinc is introduced into $ZnSO_4$ solution, a potential difference arises due to the migration of Zn^{2+} ions into the solution and accumulation of electrons in the metal, making it negatively charged. The resulting standard electrode potential for zinc is:

$E^0(Zn^{2+}/Zn) = -0.766$ V

In contrast, copper, despite having lower ionization energy than zinc, exhibits a higher standard electrode potential:

$E^0(Cu^{2+}/Cu) = +0.348$ V

This phenomenon is attributed to stronger lattice bonding and lower hydration energy in copper, making Cu^{2+} ions less likely to migrate into the solution. Consequently, copper acts as a weaker reducing agent compared to zinc.

Gas electrodes, such as the standard hydrogen electrode, are used as references with a conventionally assigned potential of **0.000 V**. The Nernst equation for the hydrogen electrode at 298 K is:

$$E_{H^+/H_2} = \frac{0.059}{1} \log \frac{a_{H^+}^2}{P_{H_2}}$$

H2=10.059logPH2aH+2

Here, PH2 is the partial pressure of hydrogen, and $O_2/Pt/OH^-$ is the activity of hydrogen ions in solution.

Gas electrodes such as $O_2/Pt/OH^-$ can also be constructed, and their potential is determined using similar principles. These electrodes are especially useful in aerospace applications due to their sensitivity and high reliability.

Conclusion

Electrode potentials are vital in understanding the chemical reactivity and electrochemical behavior of metals. Factors such as ionization energy, hydration energy, and lattice structure significantly influence a metal's electrochemical properties. The construction and analysis of galvanic cells provide valuable data for practical applications in corrosion science, battery design, and electroplating.

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