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Mass Transfer to Amalgamated Copper Rotating Disk Electrode

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ABSTRACT :

An experimental study of mass transfer to an amalgamated copper rotating disc electrode has been employed to determine an empirical correlation for the mass transfer rate in laminar flow. The study was performed in a three-electrodes configuration using 0.1 M boric acid and 0.1 M potassium chloride as supporting electrolyte with Zn (II) concentration in the range (25-100 mg dm^{-3}). Polarization curves at different zinc ion concentration are reported. Hydrogen and oxygen reduction has also been considered.The diffusion coefficients and mass transfer coefficient were obtained using limiting diffusion current technique based on zinc ion reduction. A least squares analysis indicates that the laminar flow results for $13067 < Re > 57552$ and $550 < Sc > 1390$ can be correlated by the following equation with correlation coefficient (CR) equal to 0.98: $sh = 0.61 Re^{0.5} Sc^{1/3}$

Keywords : Rotating disk electrode, Electrodepostion, Mass transfer, Zinc reduction, Amalgamated copper electrode

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1. Introduction

The rotating disc electrode has been used for investigating the hydrodynamic, kinetics and mechanism of electrochemical reaction. The hydrodynamics and the mass-transfer characteristics are well understood and current density on the disc electrode is supposed to be uniform. However, the current distribution is uniform only at the limiting current where the concentration of the reactant is zero at the electrode surface.[1)] Rotating disc electrodes (RDE) represent very practical systems for current-potential curve determination and the RDE, with precise limiting current behavior, probably is the most promising of all solid electrode systems. The rotating disc electrode solves many problems connected with the use of solid electrodes both from the experimental and theoretical point of view.

Electrochemical techniques, in particular mass-transfer measurements by limiting-current method, provide convenient and accurate means for the determination of local and average transport rates. Applying analogies between momentum, heat, and mass transport, electrochemical measurements provide insight into the fundamental aspects of transport which are convenient for obtaining transport-rate correlation. These are useful for design purposes in electrochemical system such as electrowining and electrochemical treatment of waste water. The limiting-current technique is based on driving an electrochemical reaction to its maximum possible rate where it is limited by mass transport. The limit is indicated by a current plateau" the limiting current" on a current-versus-potential plot. To calculate the limiting current i_L, Levich[2)] has obtained the solution of the convective-diffusion equation for the rotating disc electrode by applying Von Karman's hydrodynamic theory assuming that within the diffusion layer, there is no convection, an approximation which means that the variations in the velocity components must occur within distance much greater than the diffusion layer thickness by at least a factor of 10. This assumption should be verified for

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