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HORIZONTAL FLOW ROCK FILTERS FOR ALGAE REMOVAL FROM POND EFFLUENTS

BY

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ABSTRACT

Low-cost, appropriateness and effective removal of pathogens have made waste stabilization ponds (WSP) such a viable alternative for wastewater treatment. However, the presence of large quantities of algal cells in their effluents constitutes a serious drawback, albeit the need for their removal has been controversial. In the case of the WSPs in Jordan, algal removal is desirable, particularly, from an effluent reuse standpoint.

This work has been undertaken, primarily, to devise a scientific methodology for the design, prediction of long-term performance and estimation of the serviceable life of horizontal flow rock filters.

Data were obtained from a field-scale pilot filter that consisted of six filters configured in three trains. Preliminary analysis of data has shown the independent variables of filter influent total suspended solids (TSS) concentration, hydraulic detention time and water temperature, adequately explain the variation in the filter effluent TSS concentration..

A semi-empirical model accounting for ripening and void depletion has been developed. The ripening effect is described by the filter coefficient which is expressed in terms of temperature and specific deposit. Void depletion is described by detention time which in turn is expressed in terms of its initial value, initial rock bed porosity and the specific deposit. The model is the first of its kind in addressing the design and long-term performance of horizontal flow rock filters (HRkF).

The model was calibrated and verified using six sets of data. Validation was carried out using two sets of independent data. Good agreement was obtained between model predictions and actual results.

The serviceable life of the pilot filters was estimated to be in the range of 18.5 - 40.0 years depending on media grain size, influent TSS concentration, temperature, algae decomposition rate, algae type and hydraulic loading.

Sensitivity analysis of the model response and that of the serviceable life estimations have shown the latter to be particularly sensitive to the temperature sensitivity coefficient.

Charts have been produced for the design of HRkF, prediction of their long-term performance and serviceable life.

It is concluded that the horizontal flow rock filter constitutes a viable alternative for algal removal from pond effluents.

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Scanning Electrochemical Microscopy. 22. Examination of Thin Solid Films of AgBr: Ion Diffusion in the Film and Heterogeneous Kinetics at the Film/Solution Interface

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A new approach to the characterization of thin solid films, based on the use of the scanning electrochemical microscope (SECM), is described. Parameters of interest, e.g., the heterogenous rate constant for a chemical reaction at the film/solution interface and the diffusion coefficient of species inside the film, can be determined from the SECM approach curves. The analysis of the SECM current–distance curves also provides information about the spatial localization of a chemical (or electrochemical) reaction (i.e., at the substrate/film vs the film/solution interface). Silver bromide films electrodeposited on a silver substrate were used as a model experimental system to test this method, with determination of the diffusion coefficient of bromide ion in the AgBr layer (5.6×10^{-7} cm^2/s) and the heterogenous rate constant for the reaction of AgBr with hexaammineruthenium(II) (0.082 cm/s). The latter reaction occurs at a film/solution interface, in contrast with the electroreduction of tris(2,2′-bipyridyl)osmium(II) which occurs at the silver substrate surface via diffusion through pores in the AgBr film rather than at the highly resistive AgBr/solution interface.

Introduction

Various approaches to studies of the dynamic behavior of thin electroactive films[1] and the related capabilities of the scanning electrochemical microscope (SECM)[2] have been reviewed recently. The responses of two working electrodes, the SECM tip ultramicroelectrode and the substrate electrode modified with the film of interest, can provide a more comprehensive view of the often complicated metal/film/solution system than electrochemical studies of the modified electrode alone. In addition to the modified substrate electrode response that mainly reflects processes at the metal/film interface, the SECM tip can probe the film/solution interface directly from the solution side. This allows better qualitative and quantitative descriptions of such phenomena as adsorption/desorption kinetics,[3] counterion ejection and incorporation,[4] and heterogeneous processes at enzyme-modified electrodes.[5]

This paper deals with three problems related to the characterization of thin films. The first pertains to the spatial localization of chemical or electrochemical reactions. Although in some cases the locale of a reaction is clear (e.g., when anions cannot penetrate a Nafion film due to Donnan exclusion, the electrooxidation of $IrCl_6^{3-}$ occurs only at the film/solution interface[6]), for other systems the site of the reaction is not obvious. In that case, the high spatial resolution offered by the SECM can be helpful. An SECM approach (current–distance) curve[7] represents the steady-state tip current (i_T) as a function of the tip–substrate distance (d). In SECM theory, d is the distance between the tip and the plane where the regeneration of the mediator occurs (for an electronically conductive substrate) or the blocking plane (for an insulating substrate). The concept is clear with a flat unmodified substrate (e.g., a metal) but not for a substrate modified with a thin film. In the latter case, several different situations can be considered. (i) The regeneration of the mediator occurs at a film/solution interface (Figure 1A). The position of the substrate obtained from the SECM approach curve (the zero-distance point) coincides with the z coordinate of the film/solution interface (this usually can be found as the point where the tip touches the substrate) as long as the mediator regeneration is fast. Here, the shape of i_T–d curves is independent of the film thickness. (ii)

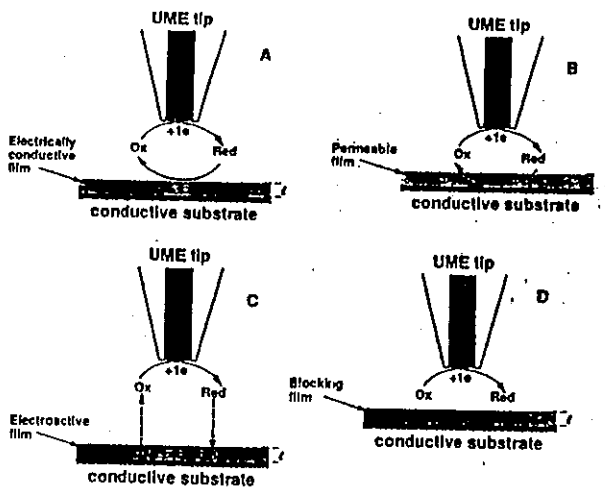

Figure 1. Schematic diagrams of the SECM experiments with four different types of mediator regeneration. (A) Regeneration of a mediator at a film/solution interface via heterogeneous chemical or electrochemical reaction (case i in the text). (B) Electrochemical regeneration of a mediator at a conductive substrate surface (case ii in the text). (C) Regeneration proceeds by reaction between film and tip generated species at the surface or within the film (case iii in the text). (D) Regeneration of a mediator at a substrate is blocked by resistive and impermeable film, resulting in negative feedback due to the hindered diffusion of redox species to the tip electrode (case iv in the text).

The mediator is regenerated at the metal/film interface (Figure 1B). If the tip does not penetrate the film, the maximum feedback current magnitude decreases with an increase in the film thickness, l, and no positive feedback current is obtained when $l \gg a$ (where a is the tip radius). The substrate position obtained from the i_T–d curve with positive feedback relates to the metal/film, rather than the film/solution, interface. If the diffusion coefficients of the mediator in solution and in the film are similar, the film thickness can be evaluated as a difference of the coordinates of the metal/film and film/solution interfaces. (iii) The regeneration proceeds by reaction between film and tip generated species at the film/solution interface or within the film (Figure 1C). In this case, the zero-point on the i_T–d curve does not correspond to either the inner or outer boundary of the film and the approach curve shape deviates significantly from simple SECM theory. Unlike case ii, the positive feedback current does not vanish with

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HYDRODYNAMICS AND STABILITY OF PLASMA SPOUTED BEDS

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As a method of contacting gas and solid, the plasma spouted bed reactor uses the plasma jet a vector for particle movement, as source of heat and as reacting fluid medium. In operating plasm spouted bed reactors, it is necessary to respect some hydrodynamic criteria to insure the syste stability (spouting regime).

The hydrodynamics and stability of plasma spouted beds are studied experimentally in a reacto unit of about 2 kg bed capacity. The influence of reactor geometry (cone angle and inlet diamete as well as solid size are investigated. The solid used during the tests is alumina (corindon) wit mean particle diameter ranging from 250 mm to 2,5 mm. Various cone angles are tested : 20°, 40° 60° and 80°. The inlet diameter (torch nozzle exit diameter) is varied between 5 to 8 mm. Th plasma gas used for most of the experiments is a mixture Ar/N2 with 20% N2. Gas flow rate vary from 10 LPM to 50 LPM. Plasma power used during the experiments varies between 10 an 30 kW.

Characterization of hydrodynamics and stability is carried out by measurement of pressure dro across the bed and by visual observations of bed behavior. The results are presented in terms o maximum spoutable bed depth, minimum spouting velocity and different regimes observed fo each set of parameters tested. For a given reactor geometry, stable spouting is showed to depen on particle size, gas flow rate and plasma power.

Simulated spin-wave resonance absorption curves and application to NiMn films

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Simulated spin wave resonace (SWR) lines for the magnetic thin films have been studied by using a surface anisotropy field together with a surface inhomogeneity model for magnetization near film surface. Landau-Lifshitz dynamic equation of motion of magnetization with Bloch type damping has been used in order to obtain absorption lines as a function of steady magnetic field applied along a general direction with respect to the film surface. It hase been found that the lineshape, resonance field values, and especially the peak intensities for higher order spin wave modes, strictly depend on the surface parameters. Using these simulations, SWR spectra of NiMn film coated with Ni (S1) and Ag (S2) layers have been analized. Sample S1 exhibits one main bulk and one surface mode whereas sample S2 exhibits two surface mode and a few higher order bulk modes, when the angle between the applied field and film normal is smaler than 25 degree. From the angular variation of the SWR spectra, it is concluded that the surface spin pinning is mainly caused by easy plane uniaxial surface anisotropy field rather than surface inhomogeneity of magnetization.

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Advances in Scanning Electrochemical Microscopy

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Abstract

The basic principles of scanning electrochemical microscopy are introduced. Recent applications of this technique to studies of fast heterogeneous and homogeneous reactions and processes occurring in thin fi (AgBr, polymers) are described. The use of novel scanning probes, e.g., i selective electrodes and enzyme electrodes, is also discussed.

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