Fuel 181 (2016) 438–449

Contents lists available at ScienceDirect

Fuel

journal homepage: www.elsevier.com/locate/fuel

Full Length Article

Hydrogen production using a platinum modified TiO_2 photocatalyst and an organic scavenger. Kinetic modeling

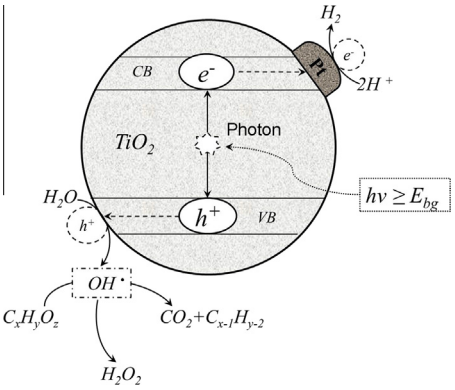
Salvador Escobedo [a], Benito Serrano [b], Alan Calzada [b], Jesús Moreira [a], Hugo de Lasa [a,*]

[a] Western University, Faculty of Engineering, Chemical Reactor Engineering Centre (CREC), London, On., Canada
[b] Universidad Autónoma de Zacatecas, Facultad de Ciencias Químicas, Zacatecas, Zac., Mexico

HIGHLIGHTS

- We report H_2 production with DP25 (TiO_2)-1 wt% Pt and an organic scavenger.
- We carried out runs in a Photo-CREC water-II unit with a H_2 collector tank.
- We observed that hydrogen formation is a near zero order reaction.
- We studied an "*In Series–Parallel*" kinetics for the conversion of organic species.
- We establish kinetic parameters for the reaction network with 95% confidence.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 2 February 2016
Received in revised form 22 March 2016
Accepted 19 April 2016

Keywords:
Near-UV light
TiO_2-Pt photocatalyst
Photo-CREC water II reactor
Hydrogen
Reaction network
Langmuir–Hinshelwood kinetic modeling

ABSTRACT

This contribution reports the kinetics of the photocatalytic production of hydrogen using a modified DP25 (TiO_2)-1 wt% Pt and ethanol as an organic scavenger. This study is carried out in a Photo-CREC water II Reactor with a specially designed H_2 collector tank. Experiments are developed under the following conditions: (a) An optimum photocatalyst loading, (b) Near-UV irradiation, (c) An acid pH and (d) Using ethanol as an organic scavenger. This research considers an "*In Series–Parallel*" kinetics to describe the photocatalytic conversion of ethanol (the organic scavenger) and of other carbon containing product species. Rate equations considered are of the Langmuir–Hinshelwood type leading to a set of ordinary differential equations. Furthermore, it is observed that hydrogen formation is a near zero order reaction. Regression analyses are used to calculate kinetic parameters with a cross-correlation matrix and 95% confidence intervals.

1. Introduction

Novel semiconductors which are photoactive under UV or visible light have gained importance as they are able to provide new alternatives for environmentally friendly hydrogen production. Semiconductors such as TiO_2 can be modified with transition metals, specifically with noble metals [1–3] enhancing photocatalysis [4–7].

A system that provides a valuable alternative for hydrogen production is the Photo-CREC water II Reactor employed in the present study [8]. The Photo-CREC water II Reactor can be operated at close to ambient pressure and temperature, using ethanol, as a sacrificial agent. This sacrificial agent can be oxidized to CO_2 and H_2O, or reduced to H_2, CH_4, C_2H_6 and other useful hydrocarbons [9]. It is

* Corresponding author.
E-mail address: hdelasa@eng.uwo.ca (H. de Lasa).

http://dx.doi.org/10.1016/j.fuel.2016.04.081
0016-2361/