EXTENDED ABSTRACT

INVESTIGATION OF HYDROGEN AND OXYGEN GASES PRODUCTION IN ALKALINE WATER ELECTROLYSIS BY APPLYING MASS TRANSFER THEORY

Arzu COSKUN AVCI
Duzce University
Graduate School of Natural and Applied Sciences, Department of Mechanical Engineering
Doctoral Thesis
Supervisor: Assoc. Prof. Dr. Ethem TOKLU
July 2018, 104 pages

1. INTRODUCTION

The fact that traditional energy sources are bordered and gathered in certain geographical areas around the world have led the country to search for new and clean energy because of the enviable environmental effects of traditional energy sources. After the 1960s, the US, Japan and European countries have focused on scientific studies on the development of alternative energy sources. Hydrogen has been regarded as a clean energy carrier for many years and has been the subject of scientific studies. Hydrogen energy has also been one of the most important alternative energy sources in recent years due to its features, potential and usage areas. It is anticipated that hydrogen will be actively involved as an energy carrier in sustainable energy research and development in the near future. In this thesis, an interdisciplinary study of electrolysis technology, which is widely used industrially, has been carried out. Also the concept of electrolysis and electrolysis has been redefined to the present with a new perspective that is unprecedented in the literature. All theoretical analyzes of hydrogen gas producing applications by water alkaline electrolysis have been carried out from a perspective of classical physics. The purpose of this thesis is to compile all the works done so far with electrolysis technology which is the most basic technology of water, to reevaluate the concept of electrolysis from the point of view of modern physics and quantum physics and to make numerical and analytical studies on energy efficiency.

2. MATERIAL AND METHODS

Within the scope of these thesis studies, a physical modeling for the alkaline electrolysis has been determined and the studies about the two-phase flow model have been carried out for this model. All expressions of void ratio, mass flow, quality, bubble velocity, surface velocity, wetting angle, bubble lifting force, current density, volumetric flow rate and production time expressions are modeled as interrelated functions for the modeled design with the help of classical physics theories. Internal and external forces acting on the resulting bubbles have been determined. The classical physics theorems are used for two-phase flow analysis.

It is difficult to solve the Schrödinger equation analytically which is common in quantum mechanics problems. Numerical solutions have been preferred in solving the Schrödinger equation analyzed in the thesis study. When the Schrödinger equation can not be directly solved, numerical methods such as Finite Difference Method are used. One of the most common methods for numerically solving time dependent partial differential equations is the finite difference method in the time domain. The main point of view of this method is to separate partial differential equations in space and time and to find approximate derivative values using the finite difference method. Within the scope of these thesis studies, calculations have been made with the finite difference method in time domain. The results obtained using the PHYTON programming language are evaluated.

3. RESULTS AND DISCUSSIONS

The most critical point of the system in hydrogen production in electrolysis is the reaction that takes place on the cathode side. In the reaction from the cathode side, an H^+ is broken off from the H_2O molecule and OH^- is formed. In this work, it is assumed that H^+ and OH^- ions are removed from each other, that is, a proton H_2O molecule is broken off. In this thesis, studies have been carried out assuming a similar situation as in the ionization of a hydrogen atom. Since the OH^- ion has the same charge as an electron in total but is heavier, it is accepted as an electron-like but heavier. While describing the reaction on the cathode side in electrolysis, the behaviors of the OH^- ion in the potential well of the ion by wave motion are described. In the representation where the proton is located at the center, it can be considered that the walls around the negatively charged ion are the electromagnetic fields generated by the proton. The OH^- ion appears to have been analyzed in an attempt to overcome its potential barrier with a wave motion.

Different wavelengths were observed in the analysis of the time domain finite element method and the quantum space tunneling application modeled for OH^- and H^+. The particle (or wave) is in consecutive trailing attempts whenever the potential engulf is hit. It has been observed that the wave function that accompanies motion when the particle is hit each time the potential barrier is out of the wall. The amplitude at the point where the wave function touched the barge abruptly lost its exponential value along the potential barrier and abandoned the barrels to the extent that it was descended due to the width of the barrier. It has been observed that the tunneling probability is highest when it reaches a potential barrier at a height till half of the waveguide's amplitude.

4. CONCLUSION AND OUTLOOK

All theoretical analyzes of hydrogen gas producing applications by water alkaline electrolysis have been carried out from a perspective of classical physics. It is known that energy efficiency is an important key point in all future work. In this thesis, a cumulative study of electrolysis technology, which was first discovered decades ago and which has been in use for decades and studied by different disciplines, has been carried out. Therefore, the interdisciplinary structure of the different dimensions of electrolysis in the thesis is important. Furthermore, the concept of electrolysis and electrolysis is redefined to a new point of view that is unprecedented in the literature up to now. In addition, the concept of electrolysis, electrolysis has been redefined to a new point of view that is unprecedented in the literature up to now. Therefore, the interdisciplinary structure of the different dimensions of electrolysis in the thesis is important.

This work reevaluated the concept of alkaline electrolysis from the point of view of modern physics and quantum physics. Particularly, approaches that are presented about energy efficiency are important. It has adapted the new concepts that the quantum physics has gained to the scientific world to energy efficiency and has given a different perspective to the literature. The approaches presented by the dissertation on energy efficiency are of particular importance. By adapting the new concepts that quantum physics has gained to the scientific world to energy efficiency, the literature has gained a different perspective. This thesis analyzes and proposes new systems to be produced today and tomorrow with regard to electrolysis by means of analytical and numerical methods which shed light on the design of new electrolysis reactors.