行政院原子能委員會

委託研究計畫研究報告

DMFC 系統控制與效率提昇之研究

Design and manufacturing of miniaturized ultrasonic methanol sensor

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中文摘要

近來燃料電池技術的快速成長，在新興能源中佔一重要地位，其中又以直接甲醇燃料電池(Direct methanol fuel cell, DMFC)較被看好，應用上由於具有高能量密度的優點，所以也被期待成為下一世代可攜式能源。由於 DMFC 的發電效率直接與甲醇燃料濃度有關係，為了即時監控燃料濃度的變化，並進一步控制燃料濃度，使 DMFC 整體之發電效率達到最佳，本計劃擬開發一微小甲醇濃度超音波感測模組來完成上述目標。而此模組將包含微小化換能器、發射/接收控制電路、速度與濃度關係資料庫、比對程式；基本原理則是利用超音波波傳特性隨著甲醇燃料溶液的濃度不同而有不同的響應，於此建立此特性與濃度之關係。

而今年的研究計畫中，分別完成初步探頭製作及其特性分析、包含甲醇流道之換能器模組、實驗環境調校及環境變因對實驗造成之誤差分析、針對需求濃度與溫度範圍內律定聲速-濃度溫度之關係、以及發射接收電路製作。並由探頭特性與聲速-濃度溫度之律定關係推估系統所需求之硬體設備，如電路發射端的脈衝波時間寬度與電壓大小以及接收端訊號分系所需之時間解析度等。並也發現利用超聲波聲速感測之盲點，進而嘗試找尋在某溫度帶內不利用聲速感測的新參數。

關鍵字：直接甲醇燃料電池、超音波、聲速、濃度

Abstract

Recently, fuel cell technology grows rapidly, and plays an important role in the emerging energy, especially for the Direct Methanol Fuel Cell (DMFC). Because the DMFC has high energy density, it is expected to be the major portable energy for the next generation. Since the performance of the DMFC is directly relevant to the density of methanol solution, in order to optimize the efficiency of DMFC, concentration changes must be monitored and controlled. This project proposes an idea of design and manufacturing of a miniaturized ultrasonic methanol sensor module. The module contains the miniaturized transducers, the Pulser/Receiver control circuit, the calibration data for the speed and concentration relations.

The research of this year has completed the manufacturing of three sets of preliminary sensors, analysis of the sensor characteristics, manufacturing of a sensor module contains methanol flow chamber, calibration of experimental environment, environment error analysis, specifying the required concentration and the temperature range, and manufacturing of pulser/receiver circuit. The specification of the ultrasonic methanol sensor including the pulse width and voltage limit for the transmitting circuit and the time resolution for receiving circuit is

then determined. Through this investigation, the blind spot of temperature range is located. Within range the sensitivity of the time-of-flight measurement for methanol density sensing is low. New parameters have to be employed for the concentration sensing in the blind temperature range.

Keywords : DMFC、ultrasound、sound speed、concentration