Università degli Studi di Messina

Consiglio Nazionale delle Ricerche

COMUNE DI MILAZZO

HYCELTEC 2024
Book of abstracts

IX Symposium on Hydrogen, Fuel Cells and Advanced Batteries
Milazzo (Italy) • June 30 - July 03, 2024

CURATORI/ EDITORS:

Baglio Vincenzo; Specchia Stefania; Lufrano Francesco; Lo Faro Massimiliano; Di Blasi Orazio; Squadrito Gaetano

Editore/Publisher

Comitato Convegni EMHYTEC

Editore/Publisher
Comitato Convegni EMHYTEC

The volume contains the collection of communications presented at the ninth edition of the Hyceltec conference held in Milazzo from 30 June to 3 July 2024. The conference is co-chaired by Vincenzo Baglio (CNR-ITAE) and Stefania Specchia (Turin Polytechnic University).

ISBN 978-88-942723-4-5

Data Pubblicazione
30/06/2024

Luogo di pubblicazione
Spadafora (ME), Italy

Optimization of methanol electrolysis cell anode channel configuration through response surface methodology

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In the search for sustainable solutions to the growing demand for hydrogen generation, methanol (MeOH) electrolysis emerges as a promising alternative to water electrolysis, showing a 70% reduction on the external energy input compared to that for water electrolysis [1,2]. MeOH electrolysers are a relatively new technology that are gaining attention in recent years, with studies analysing the components of electrolysers, as well as the operating conditions such as temperature and concentration of the MeOH supplied to the device [3]. However, apart from these parameters, the influence of the flow field is important in the anodic reaction, as it has been studied in Direct Methanol Fuel Cells (DMFC) [4]. In order to get insight into this aspect this work focuses on the study of the anode channel configuration of a methanol electrolysis cell (MEC). The parameters studied are channel depth, width and open ratio (OR). The OR is defined as the ratio between the catalytic area exposed to MeOH through the channels, and the total catalytic area. To study the influence of these parameters and their combination on the power required in the MEC, the Response Surface Methodology (RSM) is used.

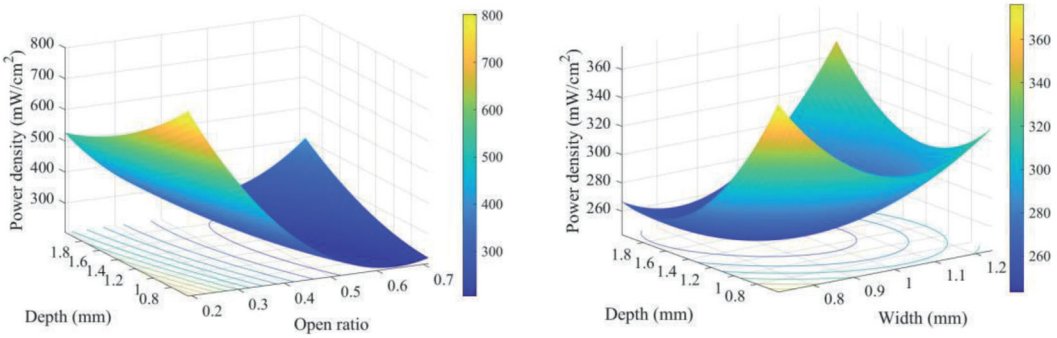

Figure 1: Power density predicted for a current density of 300 mA/cm^2 as a function of the a) channel depth and open ration keeping the channel width at 0.98 mm and b) channel depth and width for an open ratio of 45.5 %.

With a small number of tests, the application of RSM allows to obtain a second order equation that predicts the power density at a given current density as a function of the parameters studied, obtaining the surfaces shown in Figure 1. The application of the analysis of variance reveals the influence on the MEC power density of the OR and channel depth, their combination, and the quadratic term of the OR, emphasizing the importance of studying these parameters during a design process. Future research could be considered to study the physical phenomena involved and to obtain the geometry that minimises the energy supplied to the electrolyser by reducing the range of the most relevant parameters.

Acknowledgements - This work has been carried out thanks to the Project GreenH2CM funded by MCIN/AEI/10.13039/501100011033, by "NextGenerationEU/PRTR" and the Regional Government of Madrid and to the Grant PID2021-124263OB-I00 funded by MCIN/AEI/10.13039/501100011033 and by "ERDF a way of making Europe".

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ISBN 978-88-942723-4-5