Research on electrochemical reactions: reaction kinetics of low molar mass hydrocarbons for sustainable energy solutions

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In an era of growing environmental awareness and a push toward zero carbon emissions, the future of energy seems to be moving toward abandoning traditional fuels in favor of alternative energy sources such as electricity, eFuels, BioFuels and fuel cells. Against the backdrop of this trend, our research team decided to focus on the use of biofuels produced during anaerobic digestion in molten carbonate fuel cell (MCFC) power generation.

The goal of our project is to develop kinetic coefficients for the electrochemical oxidation reactions of hydrocarbons with low molar masses. We have set as a key performance indicator (KPI) to achieve model accuracy of 95%.

To achieve this ambitious goal, we used the following methodology:

1. Building a mathematical model of reaction kinetics:

   (a) Use of Aspen Hysys software to simulate the flow of a reactor (plug flow reactor).

   (b) Using MatLab/MathCad to develop an impedance model.

2 Conduct experimental studies for different fuels, quantities and temperatures:

   (a) Using gas chromatography to analyze compounds at the fuel cell outlet.

   (b) Making dedicated fuel cells.

   (c) Voltammetric testing.

   (d) EIS (electrochemical impedance spectroscopy) studies.

   (e) Post-mortem analysis based on electron microscopy (SEM).

3. analysis of the obtained EIS spectra and selection of an impedance model for the obtained spectra.

4. Analysis of the obtained current-voltage curves and selection of the model for E-i curves.

Our project will contribute to the development of an efficient and accurate model of reaction kinetics in MCFC fuel cells using biofuels, which can contribute to the development of more efficient and environmentally friendly energy solutions. As a result of this project, we expect to obtain new modeling methods and valuable experimental data to further develop and optimize fuel cell power generation processes.