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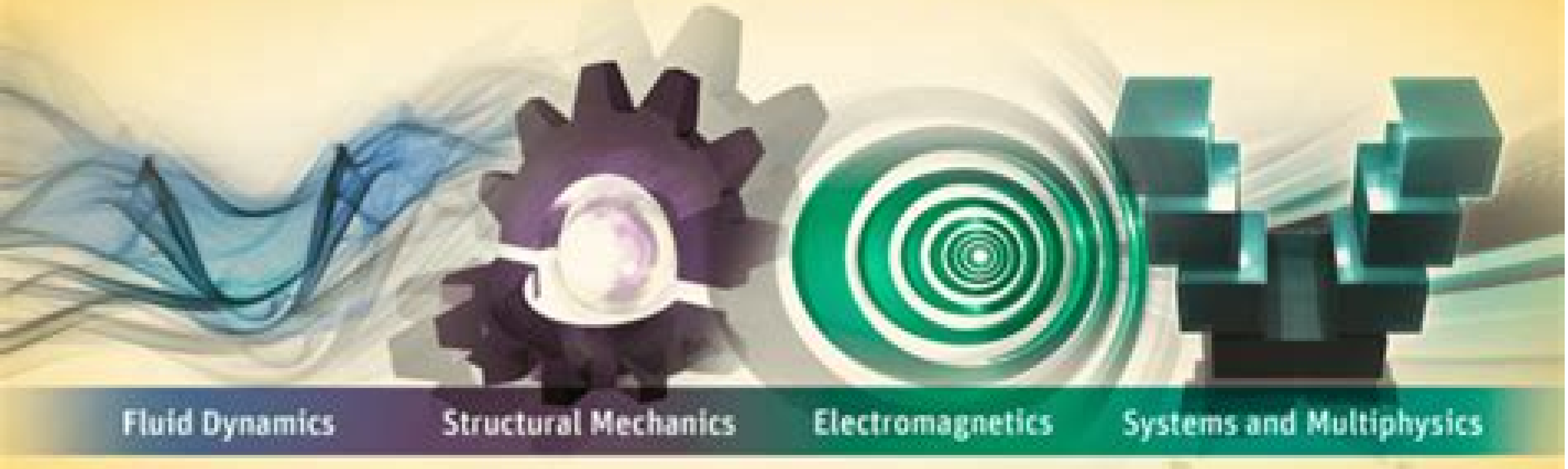
PEM Fuel Cell Modeling with ANSYS-Fluent



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April 8, 2014

Fuel Cell Modeling With Ansys Fluent

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Fuel Cell Modeling With Ansys Fluent:

Proton Exchange Membrane Fuel Cell Modeling and Simulation Using Ansys Fluent Adam Arvay,2011 Proton exchange membrane fuel cells PEMFCs run on pure hydrogen and oxygen or air producing electricity water and some heat This makes PEMFC an attractive option for clean power generation PEMFCs also operate at low temperature which makes them quick to start up and easy to handle PEMFCs have several important limitations which must be overcome before commercial viability can be achieved Active areas of research into making them commercially viable include reducing the cost size and weight of fuel cells while also increasing their durability and performance A growing and important part of this research involves the computer modeling of fuel cells High quality computer modeling and simulation of fuel cells can help speed up the discovery of optimized fuel cell components Computer modeling can also help improve fundamental understanding of the mechanisms and reactions that take place within the fuel cell The work presented in this thesis describes a procedure for utilizing computer modeling to create high quality fuel cell simulations using Ansys Fluent 12 1 Methods for creating computer aided design CAD models of fuel cells are discussed Detailed simulation parameters are described and emphasis is placed on establishing convergence criteria which are essential for producing consistent results A mesh sensitivity study of the catalyst and membrane layers is presented showing the importance of adhering to strictly defined convergence criteria A study of iteration sensitivity of the simulation at low and high current densities is performed which demonstrates the variance in the rate of convergence and the absolute difference between solution values derived at low numbers of iterations and high numbers of iterations *Fuel Cell Modeling and Simulation* Gholam Reza Molaeimanesh,Farschad Torabi,2022-11-12 Fuel Cell Modeling and Simulation From Micro Scale to Macro Scale provides a comprehensive guide to the numerical model and simulation of fuel cell systems and related devices with easy to follow instructions to help optimize analysis design and control With a focus on commercialized PEM and solid oxide fuel cells the book provides decision making tools for each stage of the modeling process including required accuracy and available computational capacity Readers are guided through the process of developing bespoke fuel cell models for their specific needs This book provides a step by step guide to the fundamentals of fuel cell modeling that is ideal for students researchers and industry engineers working with fuel cell systems but it will also be a great repository of knowledge for those involved with electric vehicles batteries and computational fluid dynamics Offers step by step guidance on the simulation of PEMFC and SOFC Provides an appendix of source codes for modeling simulation and optimization algorithms Addresses the fundamental thermodynamics and reaction kinetics of fuel cells fuel cell electric vehicles FCEVs and fuel cell power plant chapters **11th Symposium for Fuel Cell and Battery Modelling and Experimental Validation** kolektiv autorů,2014-03-05 Battery Electric Vehicles, E-Fuel Powered Hybrids and Fuel Cell Powertrains Hardikk Valera,Avinash Kumar Agarwal,2025-08-30 This book explores advanced powertrain technologies aimed at reducing greenhouse gas GHG emissions and accelerating the transition to sustainable mobility As regulatory bodies push for alternatives to internal combustion engines ICEs battery electric vehicles BEVs hybrid electric vehicles HEVs plug in hybrid electric vehicles PHEVs and fuel cell based powertrains are emerging as viable solutions However challenges such as battery safety thermal management and fuel cell efficiency require further research and innovation This book presents state of the art developments in lithium ion batteries fuel cell modeling battery thermal management systems BTMSs and electro catalyst advancements for fuel cell transportation It also discusses the technological environmental and regulatory challenges associated with electrified powertrains By providing insights into recent advancements and future prospects this book serves as a valuable resource for researchers engineers and policymakers striving to develop efficient and sustainable vehicle technologies A New PEMFC Flow Field Plate Optimization Comparison ANSYS Fluent Fuel-cell Simulation Ahmed Soueidan,2012 The performance of a new cathode flow field plate located on a PEM fuel cell was compared to an industry standard and optimal serpentine design provided from literature Results were successfully collected through a fuel cell module integrated with the 3D computational fluid dynamics package ANSYS Fluent Contour plots showing a cathode catalyst layer comparison of local current density oxygen molar concentrations water content and the pressure inside of the flow channels were compared with both PEM fuel cell configurations The new flow field plate pattern was shown to distribute more mass species of oxygen more evenly to the reaction site given the same boundary conditions thus contributing to more ideal local current density The net power was determined for both fuel cells which included the pump work in and power out from each fuel cell The new flow field plate was shown through computational power performance results to outperform the conventional flow pattern by up to 2 4% when excluding the effects of pump work and still upheld a positive gain when factoring in this value With an additional 18 corners for improved water management due to the effects of wall adhesion the new bipolar plate was proven to become a new competitor in PEM fuel cell technology Furthermore this thesis gives further insight on PEMFC digital prototyping

Mathematical and Computational Modeling of Polymer Exchange Membrane Fuel Cells Sehribani Ulusoy,2012 In this thesis a comprehensive review of fuel cell modeling has been given and based on the review a general mathematical fuel cell model has been developed in order to understand the physical phenomena governing the fuel cell behavior and in order to contribute to the efforts investigating the optimum performance at different operating conditions as well as with different physical parameters The steady state isothermal model presented here accounts for the combined effects of mass and species transfer momentum conservation electrical current distribution through the gas channels the electrodes and the membrane and the electrochemical kinetics of the reactions in the anode and cathode catalyst layers One of the important features of the model is that it proposes a simpler modified pseudo homogeneous agglomerate catalyst layer model which takes the advantage of the simplicity of pseudo homogenous modeling while taking into account the effects of the agglomerates in the catalyst layer by using experimental geometric parameters published The computation of the general mathematical model can be accomplished in 3D 2D and 1D with the proper assumptions Mainly there are two computational domains considered in this thesis The first modeling domain is a 2D Membrane Electrode Assembly MEA model including the modified agglomerate pseudo homogeneous catalyst layer modeling with consistent treatment of water transport in the MEA while the second domain presents a 3D model with different flow filed designs straight stepped and tapered COMSOL Multiphysics along with Batteries and Fuel Cell Module have been used for 2D 3D model computations while ANSYS FLUENT PEMFC Module has been used for only 3D two phase computation Both models have been validated with experimental data With 2D MEA model the effects of temperature and water content of the membrane as well as the equivalent weight of the membrane on the performance have been addressed 3D COMSOL simulation results showed that the fuel performance can be improved by using flow field designs alleviating the reactant depletion along the channels and supplying more uniform reactant distribution Stepped flow field was found to show better performance when compared to straight and tapered ones ANSYS FLUENT model is evaluated in terms of predicting the two phase flow in the fuel cell components It is proposed that it is not capable of predicting the entire fuel cell polarization due to the lack of agglomerate catalyst layer modeling and well established two phase flow modeling Along with the comprehensive modeling efforts also an analytical model has been computed by using MathCAD and it is found that this simpler model is able to predict the performance in a general trend according to the experimental data obtained for a new novel membrane Therefore it can be used for robust prediction of the cell performance at different operating conditions such as temperature and pressure and the electrochemical properties such as the catalyst loading the exchange current density and the diffusion coefficients of the reactants In addition to the modeling efforts this thesis also presents a very comprehensive literature review on the models developed in the literature so far the modeling efforts in fuel cell sandwich including membrane catalyst layer and gas diffusion layer and fuel cell model properties Moreover a summary of possible directions of research in fuel cell analysis and computational modeling has been presented *Computational Fluid Dynamics Modelling of PEM Fuel Cells* Alfredo Iranzo,A. M. Kannan,Rafiq Ahmed,Christian Suárez,Felipe Rosa,Omkar Champhekar,Clemens Fink,2026-01-01 This book explores PEM fuels cells and their potential in the energy transition PEM fuel cells are electrochemical devices that can harness hydrogen energy and transform it into electricity The book is divided into three The first section looks into the fundamentals of PEM fuel cells The second explores computational fluid dynamics CFD modeling of the dynamics of them Every section of this book contains illuminating illustrations and informative tables The final section provides bring together many practical applications and insightful recommendations catering to both newcomers to the subject and existing fuel cell professionals This book acts as useful introduction and guide to PEM fuel cells for student engineers experienced practitioners and researchers **PEM Fuel Cell Modeling and Simulation Using Matlab** Colleen Spiegel,2011-08-29 Although the basic concept of a fuel cell is quite simple creating new designs and optimizing their performance takes serious work and a mastery of several technical areas PEM Fuel Cell Modeling and Simulation Using Matlab provides design engineers and researchers with a valuable tool for understanding and overcoming barriers to designing and building the next generation of PEM Fuel Cells With this book engineers can test components and verify designs in the development phase saving both time and money Easy to read and understand this book provides design and modelling tips for fuel cell components such as modelling proton exchange structure catalyst layers gas diffusion fuel distribution structures fuel cell stacks and fuel cell plant This book includes design advice and MATLAB and FEMLAB codes for Fuel Cell types such as polymer electrolyte direct methanol and solid oxide fuel cells This book also includes types for one two and three dimensional modeling and two phase flow phenomena and microfluidics Modeling and design validation techniques Covers most types of Fuel Cell including SOFC MATLAB and FEMLAB modelling codes Translates basic phenomena into mathematical equations **Automotive Engineering International** ,2007 **2nd International Conference on the Future Sustainable Energy (ICFSE)** Hasan Sh. Majdi,Azher M. Abed,Salwan Obaid Waheed Khafaji,Mustafa Baqir Hunain,2024-06-14 Selected peer reviewed full text papers from the 2nd International Conference on the Future Sustainable Energy ICFSE 2024 Selected peer reviewed full text papers from the 2nd International Conference on the Future Sustainable Energy ICFSE 2024 February 20 22 2024 Babylon Iraq PEM Fuel Cell Modeling and Optimization Using a Genetic Algorithm Glenn Catlin,2010 The future of the world s energy solutions requires a diverse range of ideas relating to the harvest storage transmission implementation and use of various energy sources Ideally these sources are incorporated in a renewable and sustain able manner An important aspect of the efficient use of limited resources is the design of efficient systems that use these resources Hydrogen is a potential carrier of clean and renewable energy It is therefore important to increase the efficiency of the devices that utilize hydrogen as a reactant This project focuses on effective design of Polymer Electrolyte Membrane Fuel Cells PEMFCs The optimization process in this research implements a Genetic Algorithm GA to efficiently and effectively search the PEMFC design parameters that have significant influence on performance This research develops and implements a method of automatic generation of parameterized channel domains that are evaluated for performance by a computational fluid dynamics CFD technique The CFD calculations are conducted by the use of commercially available software from ANSYS The software package includes GAMBIT as the solid modeling and meshing software the solver FLUENT and a PEMFC Add on Module capable of modeling the relevant physical mechanisms that describe cell operation The result of the optimization process is a set of optimal channel parameter values for single and double serpentine channel configurations The optimal values for these parameters are identified for a PEMFC of a desired nominal area *3-dimensional Computational Fluid Dynamics Modeling of Solid Oxide Fuel Cell Using Different Fuels* Sachin Laxman Puthran,2011 Solid oxide fuel cell SOFC technology has been of great interest over many years due to its flexibility in using different fuels for operation including the fundamental fuel i e Hydrogen Various computational and numerical models have been developed along with experimental work to evaluate the performance as well as to identify and overcome the problems faced in the development of SOFC s In an attempt to achieve efficient operation with respect to design and combined thermal and electrochemical perspective the main objective of the proposed study is to present a three dimensional computational model which will serve as a framework for the analysis and optimization of SOFC s A three dimensional model of a tubular SOFC was developed to study the effect of temperature and electrolyte thickness variations on its performance A commercial Computational Fluid dynamics CFD software ANSYS FLUENT 12 0 was used for the development of the model which incorporates an interactive 3 D electro thermo chemical fluid flow analysis The particular model after validation against experimental observations for selected benchmark cases was demonstrated to be compatible for intermediate temperature operations using hydrogen as fuel The performance of the model was analyzed by varying electrolyte thicknesses from 2 100 mu m The same model was further evaluated using different fuels such as CH4 methane and CO carbon monoxide including the modeling of the reformation and the water gas shift reactions The results were compared to other computationally less expensive analytical and empirical models thus confirming the given model to be used as a basic model for future research on intermediate temperature solid oxide fuel cells Abstract leaf iii Fuel Cells Bei Gou,Woonki Na,Bill Diong,2017-12-19 Fuel Cells Modeling Control and Applications describes advanced research results on modeling and control designs for fuel cells and their hybrid energy systems Filled with simulation examples and test results it provides detailed discussions on fuel cell modeling analysis and nonlinear control The book begins with an introduction to fuel cells and fuel cell power systems as well as the fundamentals of fuel cell systems and their components It then presents the linear and nonlinear modeling of fuel cell dynamics before discussing typical approaches of linear and nonlinear modeling and control design methods for fuel cells The authors also explore the Simulink implementation of fuel cells including the modeling of PEM fuel cells and control designs They cover the applications of fuel cells in vehicles utility power systems stand alone systems and hybrid renewable energy systems The book concludes with the modeling and analysis of hybrid renewable energy systems which integrate fuel cells wind power and solar power Mathematical preliminaries on linear and nonlinear control are provided in an appendix With the need for alternative power well established we are seeing unprecedented research in fuel cell technology Written by scientists directly involved with the research this book presents approaches and achievements in the linear and nonlinear modeling and control design of PEM fuel cells Modeling and Control of Fuel Cells M. H. Nehrir,C. Wang,2009-03-11 The only book available on fuel cell modeling and control with distributed power generation applications The emerging fuel cell FC technology is growing rapidly in its applications from small scale portable electronics to large scale power generation This book gives students engineers and scientists a solid understanding of the FC dynamic modeling and controller design to adapt FCs to particular applications in distributed power generation The book begins with a fascinating introduction to the subject including a brief history of the U S electric utility formation and restructuring Next it provides coverage of power deregulation and distributed generation

DG DG types fuel cell DGs and the hydrogen economy Building on that foundation it covers Principle operations of fuel cells Dynamic modeling and simulation of PEM and solid oxide fuel cells Principle operations and modeling of electrolyzers Power electronic interfacing circuits for fuel cell applications Control of grid connected and stand alone fuel cell power generation systems Hybrid fuel cell based energy system case studies Present challenges and the future of fuel cells MATLAB SIMULINK based models and their applications are available via a companion Web site Modeling and Control of Fuel Cells is an excellent reference book for students and professionals in electrical chemical and mechanical engineering and scientists working in the FC area **Designing and Building Fuel Cells** Colleen Spiegel,2007-05-22 Acquire an All in One Toolkit for Expertly Designing Modeling and Constructing High Performance Fuel Cells Designing and Building Fuel Cells equips you with a hands on guide for the design modeling and construction of fuel cells that perform as well or better than some of the best fuel cells on the market today Filled with over 120 illustrations and schematics of fuel cells and components this one stop guide covers fuel cell applications fuels and the hydrogen economy fuel cell chemistry thermodynamics and electrochemistry fuel cell modeling materials and system design fuel types delivery and processing fuel cell operating conditions fuel cell characterization and much more Authoritative and practical Designing and Building Fuel Cells features Complete information on stack design The latest fuel cell modeling techniques Guidance on cutting edge materials and components Expert accounts of fuel cell types processing and optimization A step by step example for constructing a fuel cell Inside This State of the Art Fuel Cell Sourcebook Introduction Fuel Cell Applications Fuel Cells and the Hydrogen Economy Basic Fuel Cell Chemistry and Thermodynamics Fuel Cell Electrochemistry Fuel Cell Charge Transport Fuel Cell Mass Transport Fuel Cell Heat Transport Fuel Cell Modeling Fuel Cell Materials Fuel Cell Stack Components and Materials Fuel Cell Stack Design Fuel Cell System Design Fuel Types Delivery and Processing Fuel Cell Operating Conditions Fuel Cell Characterization **Power** ,2007 <u>Two-dimensional Along-the-channel Fuel Cell Simulation Using Fluent</u> Douglas Slingerland,2006 *Modeling Solid Oxide Fuel Cells* Roberto Bove,S. Ubertini,2008-04-20 This book fills the need for a practical reference for all scientists and graduate students who are seeking to define a mathematical model for Solid Oxide Fuel Cell SOFC simulation Structured in two parts part one presents the basic theory and the general equations describing SOFC operation phenomena Part two deals with the application of the theory to practical examples where different SOFC geometries configurations and different phenomena are analyzed in detail *Hydrogen-Air PEM Fuel Cell* Shiwen Tong,Dianwei Qian,Chunlei Huo,2018-09-24 The book presents the modeling and control of hydrogen air PEM fuel cells including simultaneous estimation of the parameters and states fuzzy cluster modeling SPM based predictive control and advanced fuzzy control MATLAB Simulink based modeling and control programs are discussed in detail With simulations and experiments it is an essential reference for both scientists and industrial engineers **Advanced Methods of Solid Oxide Fuel Cell Modeling** Jarosław Milewski,Konrad Świrski,Massimo Santarelli,Pierluigi Leone,2011-03-04 Fuel cells are widely regarded as the future of the power and transportation industries Intensive research in this area now requires new methods of fuel cell operation modeling and cell design Typical mathematical models are based on the physical process description of fuel cells and require a detailed knowledge of the microscopic properties that govern both chemical and electrochemical reactions Advanced Methods of Solid Oxide Fuel Cell Modeling proposes the alternative methodology of generalized artificial neural networks ANN solid oxide fuel cell SOFC modeling Advanced Methods of Solid Oxide Fuel Cell Modeling provides a comprehensive description of modern fuel cell theory and a guide to the mathematical modeling of SOFCs with particular emphasis on the use of ANNs Up to now most of the equations involved in SOFC models have required the addition of numerous factors that are difficult to determine The artificial neural network ANN can be applied to simulate an object s behavior without an algorithmic solution merely by utilizing available experimental data The ANN methodology discussed in Advanced Methods of Solid Oxide Fuel Cell Modeling can be used by both researchers and professionals to optimize SOFC design Readers will have access to detailed material on universal fuel cell modeling and design process optimization and will also be able to discover comprehensive information on fuel cells and artificial intelligence theory

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