

On the Efficiency of Automotive H₂/O₂ PE Fuel Cell Systems

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Abstract

Efficiency is the key argument for the application of polymer electrolyte fuel cells in automotive applications. Efficiency of the fuel cell system depends on a number of interdependent parameters. These are on the one hand the properties of the electrochemical components as well as the chosen operating conditions. On the other hand efficiency of the complete system also strongly depends on the characteristics of the balance of plant components (BoP).

The use of pure oxygen reduces the ORR over-voltage, as the oxygen partial pressure can easily be increased from typically 0.4 bar by an order of magnitude. Membrane conductivity is easier maximized with the reduced volume flow at the cathode and higher possible gas pressures. The use of pure oxygen also eliminates the need for an air compressor, the main parasitic power consumer in the BoP.

In conventional automotive systems, typically 15 – 20% of the stack power is lost for the operation of the BoP, the main power consumer being the air compressor. Typical tank to electric power efficiencies are in the order of 45%. The use of pure oxygen as the oxidant increases on the one hand the cell efficiency at the same current density and requires greatly reduced BoP parasitic power. At similar operation points, therefore the tank to electric power efficiency increases by about 20%.

Introduction

It seems probable, that future production of hydrogen will go through routes of water splitting either by electrolysis or thermochemical pathways. Pure oxygen will be a byproduct of those hydrogen generation processes. This opens up the possibility to use pure oxygen instead of air for the conversion of hydrogen to electricity in fuel cells. This paper investigates the use of pure oxygen on the overall fuel cell system efficiency for the automotive application as compared to air, including the energetic cost for the production of oxygen.

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Mike Jess



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Table of Contents Solution Manual For Fuel Cell Engines

1. Understanding the eBook Solution Manual For Fuel Cell Engines
 - The Rise of Digital Reading Solution Manual For Fuel Cell Engines
 - Advantages of eBooks Over Traditional Books
2. Identifying Solution Manual For Fuel Cell Engines
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Solution Manual For Fuel Cell Engines
 - User-Friendly Interface
4. Exploring eBook Recommendations from Solution Manual For Fuel Cell Engines
 - Personalized Recommendations
 - Solution Manual For Fuel Cell Engines User Reviews and Ratings
 - Solution Manual For Fuel Cell Engines and Bestseller Lists
5. Accessing Solution Manual For Fuel Cell Engines Free and Paid eBooks
 - Solution Manual For Fuel Cell Engines Public Domain eBooks
 - Solution Manual For Fuel Cell Engines eBook Subscription Services
 - Solution Manual For Fuel Cell Engines Budget-Friendly Options
6. Navigating Solution Manual For Fuel Cell Engines eBook Formats

- ePub, PDF, MOBI, and More
 - Solution Manual For Fuel Cell Engines Compatibility with Devices
 - Solution Manual For Fuel Cell Engines Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Solution Manual For Fuel Cell Engines
 - Highlighting and Note-Taking Solution Manual For Fuel Cell Engines
 - Interactive Elements Solution Manual For Fuel Cell Engines
 8. Staying Engaged with Solution Manual For Fuel Cell Engines
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Solution Manual For Fuel Cell Engines
 9. Balancing eBooks and Physical Books Solution Manual For Fuel Cell Engines
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Solution Manual For Fuel Cell Engines
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Solution Manual For Fuel Cell Engines
 - Setting Reading Goals Solution Manual For Fuel Cell Engines
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Solution Manual For Fuel Cell Engines
 - Fact-Checking eBook Content of Solution Manual For Fuel Cell Engines
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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