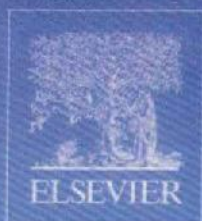


Volume 39

Issue 3

16 January 2014

ISSN 0360-3199



International Journal of **HYDROGEN ENERGY**

Editor-in-Chief:

Emre A. Veziroğlu

Senior Associate Editor:

J.W. Sheffield

Associate Editors:

**A. Basile, M.B. Goresek,
E.C. Kumbur and N.Z. Muradov**

Assistant Editors:

**F. Chen, S.L. Garrison, J. Gong,
M.D. Mat and D.P. Mishra**



includes SPECIAL SECTION

**4th International Renewable Energy
Congress (IREC), 20-22 December 2012,
Hammamet, Tunisia**

Guest Editors: Abdeslam-Hassen Meniai and Djamila Rekioua

Available online at www.sciencedirect.com

ScienceDirect





includes SPECIAL SECTION

4th International Renewable Energy Congress (IREC), 20-22 December 2012, Hammamet, Tunisia

Guest Editors:

Abdeslam-Hassen Meniai and Djamila Rekioua

[For list of contents see pp. v–vii]

Indexed/Abstracted in: *Chemical Abstracts (Online), Chemical Engineering and Biotechnology Abstracts (Online), Chimica, Compendex, Currents Abstracts, Current Contents, EnCompassLit, Energy & Power Source, Engineering Index, Environment Complete, Environment Index, International Building Services Abstracts, Inspec, PubMed, Referativnyi Zhurnal, Russian Academy of Sciences Bibliographies, Science Citation Index Expanded, TEMA-Technology and Management, Web of Science, Also covered in the abstract and citation database SCOPUS®. Full text available on ScienceDirect®.*

ISSN 0360-3199



0360-3199(20140116)39:3;1-5

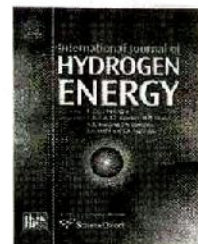


ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

International Journal of Hydrogen Energy 39 (2014) v–vii



www.elsevier.com/locate/ijhydene

Contents

Regular Articles

Hydrogen Economy

- V. BOSCAINO, R. MICELI, G. CAPPONI and G. RICCO GALLUZZO 1195 A review of fuel cell based hybrid power supply architectures and algorithms for household appliances
- J. LOU, Z. LIAO, B. JIANG, J. WANG and Y. YANG 1210 Robust optimization of hydrogen network

Solar Hydrogen

- C.G. ALMEIDA, R.B. ARAUJO, R.G. YOSHIMURA, A.J.S. MASCARENHAS, A. FERREIRA DA SILVA, C.M. ARAUJO and L.A. SILVA 1220 Photocatalytic hydrogen production with visible light over Mo and Cr-doped BiNb(Ta)O₄
- J. LUAN, N. GUO and B. CHEN 1228 Hydrogen production with Ga₂BiSbO₇, Fe₂BiSbO₇ and Cd₂BiSbO₇ as photocatalysts under visible light irradiation
- J. XING, Y.H. LI, H.B. JIANG, Y. WANG and H.G. YANG 1237 The size and valence state effect of Pt on photocatalytic H₂ evolution over platinumized TiO₂ photocatalyst

Wind Hydrogen

- G. ZHANG and X. WAN 1243 A wind-hydrogen energy storage system model for massive wind energy curtailment

Bio Hydrogen

- H. LIU, Q. ZHANG, H. HU, A. LI and H. YAO 1253 Influence of residual moisture on deep dewatered sludge pyrolysis
- L.W. DIANNINGRUM, H. CHOI, Y. KIM, K.-D. JUNG, R.F. SUSANTI, J. KIM and B.-I. SANG 1262 Hydrothermal gasification of pure and crude glycerol in supercritical water: A comparative study
- Z. MA, S.-P. ZHANG, D.-Y. XIE and Y.-J. YAN 1274 A novel integrated process for hydrogen production from biomass
- T. NOMURA, A. NAIMEN, S. TOYODA, Y. KURIYAMA, H. TOKUMOTO and Y. KONISHI 1280 Isolation and characterization of a novel hydrogen-producing strain *Clostridium* sp. suitable for immobilization
- P.R. FERREIRA ROSA, S.C. SANTOS and E.L. SILVA 1288 Different ratios of carbon sources in the fermentation of cheese whey and glucose as substrates for hydrogen and ethanol production in continuous reactors
- P. BATLLE-VILANOVA, S. PUIG, R. GONZALEZ-OLMOS, A. VILAJELIU-PONS, L. BAÑERAS, M.D. BALAGUER and J. COLPRIM 1297 Assessment of biotic and abiotic graphite cathodes for hydrogen production in microbial electrolysis cells
- A. GADHE, S.S. SONAWANE and M.N. VARMA 1306 Kinetic analysis of biohydrogen production from complex dairy wastewater under optimized condition

Methanol/Ethanol Hydrogen

J. HOU, Z.-M. LIU, G.-D. LIN and H.-B. ZHANG

1315 Novel Ni-ZrO₂ catalyst doped with Yb₂O₃ for ethanol steam reforming

Catalysts/Electrocatalysts

Y. WANG, Y. ZHAO, J. YIN, M. LIU, Q. DONG and Y. SU

1325 Synthesis and electrocatalytic alcohol oxidation performance of Pd-Co bimetallic nanoparticles supported on graphene

C. LUCARELLI, G. PAVARELLI, C. MOLINARI, S. ALBONETTI, W. MISTA, D. DI DOMENICO and A. VACCARI

1336 Catalyst deactivation in on-board H₂ production by fuel dehydrogenation

A. AL-MUSA, M. AL-SALEH, Z.C. IOAKEIMIDIS, M. OUZOUNIDOU, I.V. YENTEKAKIS, M. KONSOLAKIS and G.E. MARNELLOS

1350 Hydrogen production by iso-octane steam reforming over Cu catalysts supported on rare earth oxides (REOs)

Q. ZHAO, Z. YU, G. HAO, W. YUAN and J. LI

1364 Modulated crystalline Ag-C_i oxygen-evolving catalysts for electrocatalytic water oxidation

Storage

C.W. JAMES JR., K.S. BRINKMAN, J.R. GRAY, J.A. CORTES-CONCEPCION and D.L. ANTON

1371 Fundamental environmental reactivity testing and analysis of the hydrogen storage material 2LiBH₄·MgH₂

B.-H. CHEN

1382 Mechanical response of hydrogen-filled single-walled carbon nanotubes under torsion

S.H. BARGHI, T.T. TSOTSIS and M. SAHIMI

1390 Chemisorption, physisorption and hysteresis during hydrogen storage in carbon nanotubes

Purification/Membranes/Separation

J.A. CALLES, R. SANZ, D. ALIQUE and L. FURONES

1398 Thermal stability and effect of typical water gas shift reactant composition on H₂ permeability through a Pd-YSZ-PSS composite membrane

A. ARABI SHAMSABADI, A. KARGARI and M. BAHRAMI BABAHEIDARI

1410 Preparation, characterization and gas permeation properties of PDMS/PEI composite asymmetric membrane for effective separation of hydrogen from H₂/CH₄ mixed gas

PE Fuel Cells

M. OUATTARA-BRIGAUDET, S. BERTHON-FABRY, C. BEAUGER and P. ACHARD

1420 Correlations between the catalytic layer composition, the relative humidity and the performance for PEMFC carbon aerogel based membrane electrode assemblies

T. CUI, Y.J. CHAO and J.W. VAN ZEE

1430 Sealing force prediction of elastomeric seal material for PEM fuel cell under temperature cycling

M. NOORKAMI, J.B. ROBINSON, Q. MEYER, O.A. OBEISUN, E.S. FRAGA, T. REISCH, P.R. SHEARING and D.J.L. BRETT

1439 Effect of temperature uncertainty on polymer electrolyte fuel cell performance

S. JIA and H. LIU

1449 Direct measurement of lateral current density distribution in a PEM fuel cell with a serpentine flow field

SO Fuel Cells

F.-Y. YAN, Z.-G. LIU, J.-H. OUYANG and M.-F. YAN

1457 First-principles calculations of water dissociation on the oxygen-deficient (010) surface of Fergusonite-type LaNbO₄ crystal

E. PARK, S. TANIGUCHI, T. DAIO, J.-T. CHOU and K. SASAKI

1463 Influence of cathode polarization on the chromium deposition near the cathode/electrolyte interface of SOFC

Transportation

X. ZHANG, C. DING and T. ZHANG

1476 A hierarchical model for automotive PEM fuel cell system comprehensive evaluation and comparison

International Journal of **HYDROGEN ENERGY**

Official Journal of the International Association for Hydrogen Energy
5794 SW 40 St. #303, Miami, FL 33155, U.S.A.

FOUNDING EDITOR-IN-CHIEF: T. NEJAT VEZIROĞLU, International Association for Hydrogen Energy (IAHE), 5794 SW 40 St., #303, Miami, FL 33155, USA. Tel: 1 305 456 9353, Fax: 1 305 675 3295, Email: veziroglu@iahe.org

EMERITUS EDITORS: FRANO BARBIR, University of Split, R. Boskovicica bb, 21000 Split, Croatia.

Matthew M. Mench, Department of Mechanical, Aerospace, and Biomedical Engineering, The University of Tennessee, 234 Dougherty Building, Knoxville, TN 37996, mmench@utk.edu, 865-974-6751

S.A. SHERIF, Department of Mechanical and Aerospace Engineering, University of Florida, 232 MAE Bldg. B, P.O. Box 116300, Gainesville, FL 32611-6300, U.S.A.

EDITOR-IN-CHIEF: EMRE A. VEZIROĞLU, 1162 E. Sheffield Avenue, Chandler, Arizona 85225, USA. Tel: 1 480 855 5813, Email: emrev1@cox.net

SENIOR ASSOCIATE EDITOR: John W. Sheffield, DNV KEMA Energy & Sustainability, 60 Music Square East, Nashville, TN 37203, U.S.A.

ASSOCIATE EDITORS: ANGELO BASILE, Institute on Membrane Technology of Italian National Research Council, ITM-CNR, c/o University of Calabria, via P. Bucci Cubo 17/C, 87030 Rende CS, Italy and AST Engineering spa, Rome, Italy.

MAXIMILIAN (MAX) B. GORENSEK, Computational Sciences Directorate, Savannah River National Laboratory, Aiken, SC 29808, U.S.A.

E. CAGLAN KUMBUR, Mechanical Engineering and Mechanics, Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104, U.S.A.

NAZIM Z. MURADOV, Florida Solar Energy Center, University of Central Florida, 1679 Clearlake Road, Cocoa, FL 32922-5703, U.S.A.

ASSISTANT EDITORS: FANGLIN (FRANK) CHEN, Department of Mechanical Engineering, University of South Carolina, Columbia, SC 29208, USA

STEPHEN L. GARRISON, Computational Sciences Directorate, SRNL, Savannah River Site, Aiken, SC 29808, USA

JINLONG GONG, School of Chemical Engineering and Technology, Tianjin University, Weijin Road, Nankai District, Tianjin 300072, China

MAHMUT D. MAT, Mechanical Engineering Department, Niğde University, 51100 Niğde, Turkey

D. P. MISHRA, Combustion Laboratory, Department of Aerospace Engineering, Indian Institute of Technology, Kanpur 208016, India

ASSISTANT SUBJECT EDITORS:

Dr. Fotouh Abdul Aziz Al-Raqom 4341 NW 49th St. # 104 Gainesville, FL 32606

Dr. Pelin Bolat Energy Systems Modeling Expert Jan Van Goyenstraat 32 1816 EE Alkmaar/ NETHERLAND

A.M. KANNAN, Department of Engineering, PRLTA 335A, Arizona State University, 7171 E Sonoran Arroyo Mall, Mesa, AZ 85212

ARUNABHA KUNDU, Carrollton, KY 41008, USA

Dr. MANDHAPATI PADMANABHA RAJU, 4801, Sheboygan Ave., Apt 214, Madison, WI 53705, U.S.A.

RAMAZAN SOLMAZ, Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey

Dr. SHOHJI TSUSHIMA, Research Center for Carbon Recycling and Energy, Tokyo Institute of Technology, 2-12-1 O-okayama, Meguro-ku, 152-8552, Tokyo, Japan

Dr. Yanhui Yang 62 Nanyang Drive, N1.2-B1-18 Singapore 637459, Singapore

COMPTROLLER: AYFER VEZIROĞLU, 5794 SW 40 St. #303, Miami, FL 33155, U.S.A.

LEGAL COUNSELOR: MELVIN C. MORGENSTERN, P.O. Box 144616, Coral Gables, FL 33114, U.S.A.

COORDINATOR Liza Lopez Santos, International Association for Hydrogen Energy, 5794 SW 40 St. #303, Miami, FL 33155, U.S.A.

Change of address/Airmail delivery/Membership lists

1. IAHE members changing their address should write to: IAHE Co-ordinator, 5794 SW 40 St. #303, Miami, FL 33155, U.S.A. Other subscribers changing their address should write to the Publisher at the address below.

2. Members and subscribers in Europe, North America and Japan receive their copies by air at no extra charge. Your journal can be posted by airmail to other parts of the world and details of airmail postal rates can be obtained from the address below.

Publishing Office: Elsevier Ltd., The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, U.K. [Tel.: +44 (0) 1865 843000; fax: +44 (0) 1865 843010].

Author enquiries: For enquiries relating to the submission of articles (including electronic submission) please visit this journal's homepage at <http://www.elsevier.com/locate/ije>. For detailed instructions on the preparation of electronic artwork, please visit <http://www.elsevier.com/artworkinstructions>. Contact details for questions arising after acceptance of an article, especially those relating to proofs, will be provided by the publisher. You can track accepted articles at <http://www.elsevier.com/trackarticle>. You can also check our Author FAQs at <http://www.elsevier.com/authorFAQ> and/or contact Customer Support via <http://support.elsevier.com>.

Funding body agreements and policies: Elsevier has established agreements and developed policies to allow authors whose articles appear in journals published by Elsevier, to comply with potential manuscript archiving requirements as specified as conditions of their grant awards. To learn more about existing agreements and policies please visit <http://www.elsevier.com/fundingbodies>

Publication information: *International Journal of Hydrogen Energy* (ISSN 0360-3199). For 2014, Volume 39 (36 issues) is scheduled for publication. Subscription prices are available upon request from the Publisher, from the Regional Sales Office nearest you, or from this journal's website (<http://www.elsevier.com/locate/ijhydene>). Further information is available on this journal and other Elsevier products through Elsevier's website (<http://www.elsevier.com>). Subscriptions are accepted on a prepaid basis only and are entered on a calendar year basis. Issues are sent by standard mail (surface within Europe, air delivery outside Europe). Priority rates are available upon request. Claims for missing issues should be made within six months of the date of dispatch.

USA mailing notice: *International Journal of Hydrogen Energy* (ISSN 0360-3199) is published semimonthly by Elsevier Ltd. (The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK). Periodicals postage paid at Jamaica, NY 11431 and additional mailing offices. **USA POSTMASTER:** Send change of address to *International Journal of Hydrogen Energy*, Elsevier Customer Service Department, 3251 Riverport Lane, Maryland Heights, MO 63043, USA. **AIRFREIGHT AND MAILING** in USA by Air Business Ltd., c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA.

Language (Usage and Editing services) Please write your text in good English (American or British usage is accepted, but not a mixture of these). Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the English Language Editing service available from Elsevier's WebShop <http://webshop.elsevier.com/languageediting/> or visit our customer support site <http://support.elsevier.com> for more information.

For a full and complete Guide for Authors, please go to: <http://www.elsevier.com/locate/ije>

Orders, claims, and journal enquiries: please contact the Elsevier Customer Service Department nearest you:

St. Louis: Elsevier Customer Service Department, 3251 Riverport Lane, Maryland Heights, MO 63043, USA; phone: (877) 8397126 [toll free within the USA]; (+1) (314) 4478878 [outside the USA]; fax: (+1) (314) 4478077; e-mail: JournalCustomerService-usa@elsevier.com

Oxford: Elsevier Customer Service Department, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK; phone: (+44) (1865) 843434; fax: (+44) (1865) 843970; e-mail: JournalsCustomerServiceEMEA@elsevier.com

Tokyo: Elsevier Customer Service Department, 4F Higashi-Azabu, 1-Chome Bldg, 1-9-15 Higashi-Azabu, Minato-ku, Tokyo 106-0044, Japan; phone: (+81) (3) 5561 5037; fax: (+81) (3) 5561 5047; e-mail: JournalsCustomerServiceJapan@elsevier.com

Singapore: Elsevier Customer Service Department, Killiney Road, #08-01 Winsland House I, Singapore 239519; phone: (+65) 63490222; fax: (+65) 67331510; e-mail: JournalsCustomerServiceAPAC@elsevier.com

Advertising information: If you are interested in advertising or other commercial opportunities please e-mail Commercialsales@elsevier.com and your enquiry will be passed to the correct person who will respond to you within 48 hours.

International Journal of Hydrogen Energy has no page charges

Printed by Henry Ling, The Dorset Press, Dorchester, UK

© The paper used in this publication meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper)

International Journal of
HYDROGEN ENERGY 

Official Journal of the International Association for Hydrogen Energy
5794 SW 40 St. #303, Miami, FL 33155, U.S.A.

FOUNDING EDITOR-IN-CHIEF: T. NEJAT VEZİROĞLU, International Association for Hydrogen Energy (IAHE), 5794 SW 40 St., #303, Miami, FL 33155, USA, Tel: 1 305 456 9353, Fax: 1 305 675 3295, Email: veziroglu@iahe.org

EMERITUS EDITORS:

FRANO BARBIR, University of Split, R. Boskovic bb, 21000 Split, Croatia.

Matthew M. Mench, Department of Mechanical, Aerospace, and Biomedical Engineering, The University of Tennessee, 234 Dougherty Building, Knoxville, TN 37996, mmench@utk.edu, 865-974-6751

S.A. SHERIF, Department of Mechanical and Aerospace Engineering, University of Florida, 232 MAE Bldg. B, P.O. Box 116300, Gainesville, FL 32611-6300, U.S.A.

EDITOR-IN-CHIEF: EMRE A. VEZİROĞLU, 1162 E. Sheffield Avenue, Chandler, Arizona 85225, USA, Tel: 1 480 855 5813, Email: emrevl@cox.net

SENIOR ASSOCIATE EDITOR: JOHN W. SHEFFIELD, DNV KEMA ENERGY & SUSTAINABILITY, 60 MUSIC SQUARE EAST, NASHVILLE, TN 37203, U.S.A.

ASSOCIATE EDITORS:

ANGELO BASILE, Institute on Membrane Technology of Italian National Research Council, ITM-CNR, c/o University of Calabria, via P. Bucci Cubo 17/C, 87030 Rende CS, Italy and AST Engineering spa, Rome, Italy.

MAXIMILIAN (MAX) B. GORENSEK, Computational Science Directorate, Savannah River National Laboratory, Aiken, SC 29808, U.S.A.

E. C. KUMBUR, Mechanical Engineering and Mechanics, Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104, U.S.A.

NAZIM Z. MURADOV, Florida Solar Energy Center, University of Central Florida, 1679 Clearlake Road, Cocoa, FL 32922-5703, U.S.A.

ASSISTANT EDITORS:

FANGLIN (FRANK) CHEN, Department of Mechanical Engineering, University of South Carolina, Columbia, SC 29208, USA

STEPHEN L. GARRISON, Computational Sciences Directorate, SRNL, Savannah River Site, Aiken, SC 29808, USA

JINLONG GONG, School of Chemical Engineering and Technology, Tianjin University, Weijin Road, Nankai District, Tianjin 300072, China.

MAHMUT D. MAT, Mechanical Engineering Department, Niğde University, 51100 Niğde, Turkey

D. P. MISHRA, Combustion Laboratory, Department of Aerospace Engineering, Indian Institute of Technology, Kanpur 208016, India

ASSISTANT SUBJECT EDITORS:

Dr. FOTOUH ABDUL AZIZ AL-RAQOM 4341 NW 49th St. # 104 Gainesville, FL 32606

Dr. PELIN BOLAT Energy Systems Modeling Expert Jan Van Goyenstraat 32 1816 EE Alkmaar/ NETHERLAND

A.M. KANNAN, Department of Engineering, PRLTA 335A, Arizona State University, 7171 E Sonoran Arroyo Mall, Mesa, AZ 85212

ARUNABHA KUNDU, Carrollton, KY 41008, USA

Dr. MANDHAPATI PADMANABHA RAJU, 4801, Sheboygan Ave., Apt 214, Madison, WI 53705, USA

RAMAZAN SOLMAZ, Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey

Dr. SHOHJI TSUSHIMA, Research Center for Carbon Recycling and Energy Tokyo Institute of Technology 2-12-1 O-okayama, Meguro-ku 152-8552, Tokyo, Japan

Dr. YANHUI YANG 62 Nanyang Drive, N1.2-B1-18 Singapore 637459, Singapore

HONORARY EDITORIAL BOARD

HUSSEIN K. ABDEL-AAL, Chemical Engineering H.I.T., 18 Jeddah Street, Doki, Cairo, Egypt.

LUIS A. AVACA, Instituto de Física e Química de Sao Carlos, Universidade de Sao Paulo, Sao Carlos, Brazil.

ROGER E. BILLINGS, Energy Innovations Inc., 26900 East Pink Hill Road, Independence, MO 64057-3284, U.S.A.

DAVID L. BLOCK, Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, FL 32922-5703, U.S.A.

WILLIAM J. D. ESCHER, Madison, AL 35758-6614, U.S.A.

DANIEL FRUCHART, Laboratory of Crystallography, CNRS, BP 166, 38042 Grenoble Cedex 9, France.

VICTOR A. GOLTSOV, Physics Department, Donetsk State Technical University, 58 Artem Street, Donetsk 340000, Ukraine.

DEREK P. GREGORY, Building Services Research and Information Association, Bracknell, Berkshire RG12 4AH, U.K.

SADIK KAKAÇ, Mechanical Engineering Department, Middle East Technical University, Ankara, Turkey.

GHAZI A. KARIM, Department of Mechanical and Manufacturing Engineering, University of Calgary, 2500 University Drive, N.W., Calgary, Alberta, Canada T2N 1N4.

K. F. KNOCHE, Lehrstuhl für Technische Thermodynamik, RWTH-Aachen, D52056 Aachen, Germany.

PETER LEHMAN, Schatz Energy Research Center, Humboldt State University, Arcata, CA 95521-8299, U.S.A.

F. A. LEWIS, Chemistry Department, Queen's University of Belfast, Belfast, BT9 5AG, UK.

CESARE MARCHETTI, International Institute for Applied Systems Analysis, A2361 Laxenburg, Austria.

JEAN POTTIER, Direction des Etudes et Techniques Nouvelles, Gaz de France, 361 Av. du President Wilson, B.P. 33 93211, La Plaine Saint Denis Cedex, France.

SÜMER ŞAHİN, Department of Mechanical Engineering, Faculty of Engineering, Atılım University, Incek, Gölbaşı, Ankara, 06836 Turkey.

DAVID S. SCOTT, 2911 Mt. Baker View Road, Victoria, BC, Canada, V8N 1Z6.

WALTER SEIFRITZ, CH 5212 Hausen, Switzerland.

MEYER STEINBERG, Brookhaven National Laboratory, Building 475B, Upton, NY 11973-5000, USA.

PATRICK K. TAKAHASHI, Hawaii Natural Energy Institute, University of Hawaii at Manoa, 2540 Dole Street, Holmes 246, Honolulu, HI 96822, U.S.A.

HUGO VANDENBORRE, Vandenborre Technologies N.V., Brugstraat 45/1, B-2300 Turnhout, Belgium.

WILLIAM D. VAN VORST, Pacific Palisades, CA 90272-2819, U.S.A.

ASHOK K. VIJH, Institut de Recherche d'Hydro-Quebec (IREQ), 1800 Blvd Lionel Boulet, Varennes, Quebec, Canada J3X 1S1.

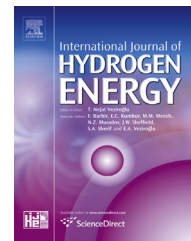
CARL-JOCHEN WINTER, ENERGON, Carl-Jochen Winter GmbH, Obere St. Leonhardstr 9, D-88662 Überlingen, Germany.

EDITORIAL BOARD

- SULEYMAN I. ALLAKHVERDIEV, Institute of Basic Biological Problems, Russian Academy of Sciences, Pushchino, Moscow Region 142290, Russia.
- SUKHVINDER BADWAL, CSIRO Manufacturing and Infrastructure Technology, Private Bad 33, Dayton South, IC 3169, Australia.
- ANGELO BASILE, Research Institute on Membrane Technology of the National Research Council, c/o UNICAL, cubo 17/C, Rende (CS), Italy and AST Engineering spa, Rome, Italy.
- S.Z. BAYKARA YILDIZ, Technical University, Esenler - Istanbul, Turkey
- MOHAMED BOUODINA, Physics Department, College of Science, University of Bahrain, PO Box 32038, Bahrain.
- PING CHENG, Department of Mechanical Engineering, Hong Kong University, Hong Kong.
- DEBABRATA DAS, Department of Biotechnology, Indian Institute of Technology, Kharagpur, 721302, India.
- ANDREW DICKS, School of Engineering, University of Queensland, Brisbane 4072, Queensland, Australia.
- IBRAHIM DINCER, Faculty of Engineering and Applied Science, University of Ontario Institute of Technology (UOIT), 2000 Simcoe Street North, Oshawa, Ontario L1H 7K4, Canada.
- NEDJIB DJILALI, Director, Institute Integrated Energy Systems (IESVic) University of Victoria, P.O. Box 3055, Victoria BC V8W 3P6, Canada.
- JUERGEN GARCHE, ZSW-Center for Solar Energy and Hydrogen Research, Baden-Wuerttemberg, Helmholtzstrasse 8, D-8908 Ulm, Germany.
- ERNESTO RAFAEL GONZALEZ, Universidad de Sao Paulo, Instituto de Quimica de Sao Carlos, Av. Dr. Carlos Botelho 1465, Caixa Postal 780-CEP 13560-970, Sao Carlos-SP, Brazil.
- LIEJIN GUO, School of Energy and Power Engineering, Xi'an Jiatong University, 710049 Shaanxi Province, China.
- Z. B. GÜVENC, Faculty of Engineering and Architecture, Cankaya University, Ankara, Turkey.
- KEVIN KENDALL, School of Engineering Chemical Engineering, The University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK.
- JOHN KILNER, Head of Department of Materials, Imperial College of Science, Technology & Medicine, Prince Consort Road, London, SW7 2BP, UK.
- CHANG-SOO KIM, Fuel Cell Research Team, Korea Institute of Energy Research, 71-2 Jang-dong, Yusong-ku, P. O. Box 103, Yosong-Gu, Taejon 305-453, South Korea.
- XIANGUO LI, Dept. of Mechanical Engineering, University of Waterloo, 200 University Ave. West, Waterloo, Ontario, N2L 3G1 Canada.
- HONGTAN LIU, Department of Mechanical Engineering, University of Miami, PO Box 248294, Coral Gables, FL 33124, U.S.A.
- KE LIU, Hydrogensource LLC/UTC Fuel Cells, 60 Bidwell Road, South Windsor, CT 06074, U.S.A.
- STANISLAV P. MALYSHENKO, Institute for High Temperatures (IVTAN) of RAS, Krasnokazarmen-naja 17a, 111250 Moscow, Russia.
- ARNOLD R. MILLER, Vehicle Projects Inc, 200 Violet Street, Suite 100, Golden, CO 80401, U.S.A.
- JANUSZ NOWOTNY, Centre for Materials Research and Energy Conversion, University of New South Wales, Sydney NSW 2052, Australia.
- KEN-ICHIRO OTA, Department of Energy and Safety Engineering, Yokohama National University, 79-5 Tokiwadai, Hodogaya-ku, Yokohama 240-8501 Japan.
- BRUNO G. POLLET, HySA Systems Competence Centre, SAIAMC, University of the Western Cape, Modderdam Road, Private Bag X17, Bellville 7535, Cape Town, South Africa.
- ALI RAISSI, Director Hydrogen Division, Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, FL 32922-5703, U.S.A.
- TOM R. RALPH, Johnson Matthey Technology Centre, Sonning Common, Reading RG4 9H, UK.
- NIGEL M. SAMMES, Director, Connecticut Global Fuel Cell Center, University of Connecticut, 44 Weaver Road, Unit 5233 Storrs, 06269-5233, U.S.A.
- O. SAVADOGO, Laboratoire d'Electrochimie et de Materiaux Energetiques, Ecole Polytechnique de Montreal, C. P. 6079, succ. Centre-Ville, Montreal (Quebec), Canada H3C 3A7.
- KEITH SCOTT, School of Chemical Engineering and Advanced Materials, University of Newcastle, Merz Court, Newcastle upon Tyne NE1 URU, U.K.
- P. JOSEPH SEBASTIAN, Centro de Investigacion en Energia-UNAM, 62580 Tomixco, Morelos, Mexico.
- MANISH SINHA, Fuel Cell Activities, General Motors, 11 Carriage Street, Honeoye Falls, NY 14472, U.S.A.
- O. N. SRIVASTAVA, Department of Physics, Banaras Hindu University, Varanasi 22 10005, India.
- HIROHISA UCHIDA, Department of Research Promotion, Graduate/Undergraduate Schools of Engineering, Tokai University, Kita-Kanami, Hiratsuka, Kanagawa 259-1292, Japan.
- OYSTEIN ULLEBERG, Institutt for Energieteknikk, Postboks 40, 2007 Kjeller, Norway.
- FRANCISCO A. URIBE, Los Alamos National Laboratory, MPA-11, MS D429, Los Alamos, NM 87545, U.S.A.
- JOHN W. VAN ZEE, Department of Chemical Engineering, University of South Carolina, Columbia, SC 29208, U.S.A.
- CHAO-YANG WANG, Director, Electrochemical Engine Center, Department of Mechanical & Nuclear Engineering, Pennsylvania State University, 338A REBER BUILDING, University Park, PA 16802-1412.
- YUDA YURUM, Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul 34956, Turkey.

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ijhydene

Hydrothermal gasification of pure and crude glycerol in supercritical water: A comparative study

Laras W. Dianningrum^{a,b}, Haemin Choi^a, Yunje Kim^a, Kwang-Deog Jung^a, Ratna F. Susanti^c, Jaehoon Kim^{d,e,*}, Byung-In Sang^{f,**}

^a Clean Energy Research Center, Korea Institute of Science and Technology, Hwarangno 14-gil 5, Seongbuk-gu, Seoul 136-791, Republic of Korea

^b Department of Clean Energy and Chemical Engineering, University of Science and Technology, 113 Gwahangno, Yuseong-gu, Daejeon 305-333, Republic of Korea

^c Chemical Engineering Department, Industrial Technology Faculty, Parahyangan Catholic University, Ciumbuleuit 94, Bandung, West Java 40141, Indonesia

^d School of Mechanical Engineering, Sungkyunkwan University, 2066, Seobu-Ro, Jangan-Gu, Suwon, Gyeong Gi-Do 440-746, Republic of Korea

^e SKKU Advanced Institute of Nano Technology (SAINT), 2066, Seobu-Ro, Jangan-Gu, Suwon, Gyeong Gi-Do 440-746, Republic of Korea

^f Department of Chemical Engineering, Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul 133-791, Republic of Korea

ARTICLE INFO

Article history:

Received 6 May 2013

Accepted 25 October 2013

Available online 9 December 2013

Keywords:

Hydrogen

Crude glycerol

Supercritical water

FAMES

Batch system

Continuous system

ABSTRACT

A comparative gasification study between pure glycerol and two different kinds of crude glycerol is conducted in supercritical water under various operating parameters to investigate the effect of different compositions in crude glycerol on the gasification behaviors. Among various types of impurities in the crude glycerol, fatty acid methyl esters (FAMES) exhibit a negative effect on the gas yield and gasification efficiency of crude glycerol in a batch apparatus due to the enhanced tar/char formation. At 650 °C and 5 wt%, gasification in a continuous apparatus exhibits H₂ yields of 26.44 and 35.85 mmol/g feed in 1 min for both types of crude glycerol, which could not be achieved by the batch system even with the reaction time extended up to 120 min. A shorter duration in the non-supercritical state may be the dominant parameter that leads to complete conversion of FAMES and total gasification of crude glycerol using the continuous system.

Crown Copyright © 2013, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

1. Introduction

The huge amount of crude glycerol generated currently makes biodiesel production plants unattractive from an economic

point of view, because of the chemical complexity of crude glycerol due to the presence of a large variety of impurities, such as water, soap, traces of methanol, unseparated fatty acid methyl esters (FAMES), and many other inorganic

* Corresponding author. School of Mechanical Engineering, Sungkyunkwan University, 2066, Seobu-Ro, Jangan-Gu, Suwon, Gyeong Gi-Do 440-746, Republic of Korea. Tel.: +82 31 299 4843; fax: +82 31 290 5889.

** Corresponding author. Tel.: +82 2 2220 2328; fax: +82 2 2220 4716.

E-mail addresses: jaehoonkim@skku.edu, kjh0508@gmail.com (J. Kim), biosang@hanyang.ac.kr (B.-I. Sang).

0360-3199/\$ – see front matter Crown Copyright © 2013, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved. <http://dx.doi.org/10.1016/j.ijhydene.2013.10.139>