

PROCEEDING SENTIN⁺

Symposium of Emerging Nuclear Technology and Engineering Novelty (2018)

Palembang, July 4-5th 2018



National Nuclear Energy Agency
Deputy for Nuclear Energy Technology

Sriwijaya University

IOP Publishing

Symposium of Emerging Nuclear Technology and Engineering Novelty (SENTEN 2018)

Discovery Science and Engineering Novelty
for Improving Human Life Prosperity

Journal of Physics: Conference Series
Volume 1198

Palembang, Indonesia
4 – 5 July 2018

Part 1 of 2

ISBN: 978-1-5108-8785-5
ISSN: 1742-6588

**DEWAN EDITOR /
PENILAI KARYA TULIS ILMIAH:**

KETUA:

Dr. Geni Rina Sunaryo, M.Sc. (BATAN)

Wakil Ketua:

Prof. Subriyer Nasir (Universitas Sriwijaya)

Dr. Ir. P. Made Udiyani, M.Si (BATAN)

SEKRETARIS:

Syaiful Bakhri, Ph.D. (BATAN)

Dr. Julwan Hendri Purba (BATAN)

ANGGOTA:

Ir. DT Sony Tjahyani, M.Eng (BATAN)

Dr. Mulya Juarsa (BATAN)

Dr. Arya Adhyaksa Waskita (BATAN)

Dr. R. Muhammad Subekti (BATAN)

Rafiuddin Syam, Ph.D. (Universitas Hassanuddin)

Tim Prosiding:

Suwoto, Ihda Husnayani, Farisy Yogatama, Wahid Luthfi, Muksin Aji Setiawan

Symposium of Emerging Nuclear Technology and Engineering Novelty (SENTEN 2018)

PREFACE

Following the previous successful of SENTEN-ICoNETS 2015-2017, five research centers under the Deputy of Nuclear Energy Technology – National Nuclear Energy Agency of Indonesia (BATAN) in collaboration with Universitas Sriwijaya organize the First Symposium of Emerging Nuclear Technology and Engineering Novelty (SENTEN) with theme: “Discovering Science and Engineering Novelty for improving human life prosperity”. SENTEN 2018 has been conducted in Horison Ultima Hotel, Palembang, South Sumatra, Indonesia, on 4-5 July 2018. This conference aims at summarizing recent research activities relevant to the nuclear, material, mechanical, electric, chemical, geology, architect and civil engineering, computer science and IT, food and agriculture, and also facilitate communication among relevant experts.

More than 150 people from Indonesia, Malaysia, India, Taiwan, and some other countries have participated in this conference. About 207 presentations including 6 keynote speeches and 1 plenary talk are presented. The presentations are grouped into 9 areas of particular interest: (1) Nuclear Science and Engineering, (2) Material Science and Engineering, (3) Mechanical and Industrial Engineering, (4) Electrical Science and Engineering, (5) Chemical Science and Engineering, (6) Geological Science and Mining Engineering, (7) Architecture and Civil Engineering, (8) Computer Science and Information Technology, and (9) Food and Agricultural Science, Natural Resource Science.

From about 190 full papers submitted, then peer-reviewed by relevant experts, eventually 169 papers were accepted for publication in this proceeding. We are indebted to all of authors for submitting their original papers.

We would like to thank all participants, and express our gratitude to all those who helped the success of this conference.

Syaiful Bakhri

SENTEN 2018 Chairman

Peer review statement

All papers published in this volume of Journal of Physics: Conference Series have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing

Reviewer Board

The Reviewers Board for SENTEN 2018 :

1. Prof. Dr. Djarot S. Wisnubroto (BATAN, Indonesia)
2. Prof. Dr. Nesimi Ertugrul (UoA, Australia)
3. Prof. Dr. Nguyen Trung Tinh (TIC-VARNS, Vietnam)
4. Prof. Dr.-Ing. Nandy Putra (UI, Indonesia)
5. Prof. Dr. Jung Jae-cheon (KINGS, Korea)
6. Prof. Dr. Ridwan (BATAN, Indonesia)
7. Prof. Dr. Ir. Dedi Priadi, DEA. (UI, Depok)
8. Prof. Dr. Akio Gofuku (Okayama Univ, Japan)
9. Prof. Dr. Ir. H. Anis Saggaff, MSCE (Sriwijaya University, Indonesia)
10. Prof. Ir. Zainuddin Nawawi, Ph.D (Sriwijaya University, Indonesia)
11. Prof. Subriyer Nasir (Sriwijaya University, Indonesia)
12. Prof. Erika Buchari (Sriwijaya University, Indonesia)
13. Prof. Eddy Sutriyono (Sriwijaya University, Indonesia)
14. Prof. Iskhaq Iskandar, Ph.D (Sriwijaya University, Indonesia)
15. Prof. Siti Nurmaini ((Sriwijaya University, Indonesia)
16. Prof. Kaprawi (Sriwijaya University, Indonesia)
17. Prof. Muhammad Said (Sriwijaya University, Indonesia)
18. Prof. Eddy Ibrahim (Sriwijaya University, Indonesia)
19. Prof. Hasan basri (Sriwijaya University, Indonesia)
20. Dr. Hadid Subkhi (IAEA)

21. Dr. Frederik Reitsma (IAEA)
22. Dr. Jim Kuijper (NRG, Netherlands)
23. Dr. Mark Mitchell (PBMR, South Africa)
24. Dr. Mike Davies (AFW, UK)
25. Dr. Kunihiko Nabeshimaa(JAEA-Japan)
26. Dr. Sun Jun (Tsinghua University, China)
27. Dr. Phongpaeth Pengvanich (CU,Thailand)
28. Dr. Sidik Permana (IT, Indonesia)
29. Dr. Alexander Agung (UGM, Indonesia)
30. Dr. Deendarlianto (UGM, Indonesia)
31. Dr. Geni Rina Sunaryo (BATAN, Indonesia)
32. Syaiful Bakhry, Ph.D (BATAn, Indonesia)
33. Dr. Ir. P. Made Udiyani, M.Si (BATAN, Indonesia)
34. Ir. DT Sony Tjahyani, M.Eng (BATAN, Indonesia)
37. Dr. Hendro Tjahyono (BATAN, Indonesia)
38. Dr. R. Muhammad Subekti (BATAN, Indonesia)
39. Dr. Julwan Hendry Purba (BATAN, Indonesia)
40. Dr. Mulya Juarsa (BATAN, Indonesia)
41. Dr. Arya Adhyaksa Waskita (BATAN, Indonesia)
42. Rafiuddin Syam, Ph.D. (UNHAS, Indonesia)
43. Dr. Wayan Nata Septiadi (UNUD, Indonesia)

TABLE OF CONTENTS

PART 1

NUCLEAR SCIENCE AND ENGINEERING

SHORT CIRCUIT ANALYSIS ON HPS ELECTRICAL SYSTEM	1
<i>Khairul Handono, Edy Sumarno, Kiswanta, Koes Indrakoesoema</i>	
POWER FLOW ANALYSIS ON RDE FUEL HANDLING SYSTEM USING ETAP	9
<i>Edy Sumarno, Khairul Handono, Kiswanta, Koes Indrakoesoema</i>	
COMPARISON OF GALLIUM-68 PRODUCTION YIELDS FROM (P,2N), (α,2N) AND (P,N) NUCLEAR REACTIONS APPLICABLE FOR CANCER DIAGNOSIS	19
<i>I Kambali, F A Wibowo</i>	
ANALYSIS OF HEAVY METAL LOADING OPTIMIZATION THROUGH CRITICALITY CALCULATION ON RDE	29
<i>Suwoto, H. Adrial, Zuhair, K. Kamajaya, S. Bakhri</i>	
NUCLEAR POWER PLANT MAINTENANCE OPTIMISATION: MODELS, METHODS & STRATEGIES	40
<i>I Wayan Ngarayana, Thi-Mai-Dung Do, Kenta Murakami, Masahide Suzuki</i>	
TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) ANALYSIS OF BANGKA TIN SLAG	63
<i>Onek Gunawan, Eko Pudjadi, Musaddiq Musbach, Wahyudi</i>	
DETERMINATION OF DIFFUSION COEFFICIENT OF ¹³⁷CS AT UNSATURATED ZONE OF DH-2 SITE SOIL UNDER $\delta = 1.41 \text{ G.CM}^{-3}$ CONDITION	70
<i>Budi Setiawan, Nurul Efri Ekaningrum</i>	
CALCUIYIELD: A NOVEL ANDROID-BASED SOFTWARE FOR RADIOACTIVITY YIELD CALCULATIONS	78
<i>F A Wibowo, I Kambali</i>	
WATER EVAPORATION RATE OF RSG-GAS SPENT FUEL STORAGE POOL	86
<i>Titik Sundari, Mukhsimun Hadi Kusuma, Budiyono, M. Joko Puspito, Parjono, Darmawan Aji, Irwan Santoso, Sri Ismarwanti</i>	
IMPROVEMENT OF NUCLEAR SCIENCE STANDARDS (SNI) TO MEET MARKET NEEDS AND HARMONIZATION	101
<i>J. Sutanto, P. Sulisworo</i>	
ANALYSIS FOR DEVELOPING A CLEARING HOUSE OF NUCLEAR TECHNOLOGY USING SWOT-BSC STRATEGIES	107
<i>A. Bayu Purnomo, Jepri Sutanto</i>	
CROSS-SECTIONAL IMAGING OF TREE STEM DENSITY DISTRIBUTION USING GAMMA-RAY TOMOGRAPHY TECHNIQUE	114
<i>Wibisono, Bayu Azmi, Sastra Kusuma Wijaya, Prawito, Firliyani Rahmatia Ningsih</i>	
INFLUENCE ANALYSIS OF NATURAL VENTILATION SYSTEM ON RADON CONCENTRATION IN INTERIM STORAGE FOR RADIOACTIVE WASTE	121
<i>R. Ratiko</i>	
A SELF-EVALUATION TOOLS FOR THE ASSESSMENT OF NUCLEAR FORENSIC CAPABILITY	129
<i>Nurul Ilyani Zaharudin, Phongphaeth Pengvanich</i>	
REVERSE ENGINEERING PROGRAM USING MBSE TO SUPPORT DEVELOPMENT OF I&C SYSTEM EXPERIMENTAL POWER REACTOR FROM PLC TO FPGA.	139
<i>Restu Maerani, Deswandri, Sigit Santoso, Sudarno, Ign. Djoko Irianto</i>	
TRANSIENT ANALYSIS OF CVCS MALFUNCTION IN LARGE PASSIVE PWR	152
<i>Surip Widodo, Andi Sofrany Ekariansyah</i>	
EVALUATION OF FUEL BURN-UP AND RADIOACTIVITY INVENTORY IN THE 2 MW TRIGA-PLATE BANDUNG RESEARCH REACTOR	160
<i>M Budi Setiawan, S Kuntjoro, P M Udiyani, I Husnayani</i>	
APPLICABILTY STUDY OF ULTRASONIC FLAW DETECTOR FOR NUCLEAR GRADE GRAPHITE EXAMINATION	167
<i>Roziq Himawan, Freddy Lie, Prita Dewi Basoeki, Mudi Haryanto</i>	

PRELIMINARY STUDY OF TEMPERATURE HOMOGENISATION IN EXPERIMENTAL POWER REACTOR HOT GAS CHAMBER.....	175
<i>R Andika Putra Dwijayanto, Muhammad Subekti</i>	
A COMPARATIVE STUDY ON SAFETY DESIGN REQUIREMENTS BETWEEN HTGR AND LWR	182
<i>Julwan Hendry Purba, Damianus Toersiw Sany Tjahyani</i>	
INVESTIGATION OF GRAPHITE MATRIX ACTIVATION IN THE FUEL PEBBLE OF REAKTOR DAYA ESKPERIMENTAL.....	190
<i>I Husnayani, P M Udiyani, S Kuntjoro, M B Setiawan</i>	
COMPARATIVE STUDY OF RDE AND CONVENTIONAL PLANT FOR MODERATE SCALE POWER GENERATIONS.....	195
<i>S Sudadiyo, T Taryo, E Saragi, Krismawan</i>	
COMMISSIONING PREPARATION OF A SUBCRITICAL EXPERIMENTAL FACILITY FOR 99MO PRODUCTION	205
<i>Syarip, P I Wahyono, W Susilo, K Donny</i>	
DESIGNING INSTRUMENTATION AND CONTROL SYSTEM FOR POWER CONTROL AND SHUTDOWN SYSTEM OF RDE	213
<i>Agus Cahyono, Demon Handoyo, Kristedjo Kurnianto, Deswandri</i>	
ANALYSIS OF IRRADIATED PEBBLE BED FUEL TRANSFER SYSTEM IN HOT CELL 101 RADIOMETALLURGY INSTALLATION.....	220
<i>Helmi Fauzi Rahmatullah, Rohmad Sigit, Sri Ismarwanti, Erlina Noerpitari, Maman Kartaman Ajiriyanto, Jan Setiawan</i>	
CORRELATION BETWEEN DIFFERENT TYPE OF CAESIUM CARRIER IN THE RADIOCAESIUM INTERCEPTION POTENTIAL MEASUREMENT FOR FOREST SOILS.....	228
<i>Hendra A Pratama, M Yoneda, Y Shimada, F Satoshi, M Ikegami</i>	
REGULATORY ASSESSMENT ON A NEW UTILIZATION OF SAMOP TEST FACILITY: DETERMINATION ON FISSION POWER.....	238
<i>Azizul Khakim</i>	
FUEL BURN-UP AND RADIOACTIVITY INVENTORY ANALYSIS FOR NEW IN-CORE FUEL MANAGEMENT OF THE RSG-GAS RESEARCH REACTOR.....	246
<i>S Kuntjoro, P M Udiyani, M Budi Setiawan</i>	
DESIGN CRITERIA OF INSTRUMENTATION AND CONTROL IN FUEL HANDLING SYSTEM OF RDE	253
<i>Dian Fitri Atmoko, Achmad Suntoro, Deswandri</i>	
TRADE-OFF ANALYSIS BETWEEN PLC AND FGPA FOR THE SYSTEM PLATFORM OF INSTRUMENTATION AND CONTROL SYSTEM EXPERIMENTAL POWER REACTOR: A PRELIMINARY STUDY.....	260
<i>Saharudin, Restu Maerani</i>	
STUDY ON MOX CORE CHARACTERISTICS OF EXPERIMENTAL POWER REACTOR USING MCNP6 CODE	268
<i>Zuhair, Suwoto, H. Adrial, T. Setiadipura</i>	
CONTROL ROD REACTIVITY ANALYSIS OF ONE STUCK ROD CONDITION IN 10 MWTH EXPERIMENTAL REACTOR CONCEPTUAL DESIGN (RDE-10 MWTH) ON FIRST FULL CORE	278
<i>H. Adrial, Suwoto, A. Hamzah, Zuhair</i>	
BENCHMARKING OF EXPERIMENTAL SETUP FOR PRESSURE DROP CALCULATION IN A PACKED PEBBLE BED USING RELAP5.....	289
<i>A S Ekariansyah, S Widodo</i>	
INHERENT SAFETY ANALYSIS OF THE UO₂ FUELED PEBBLE LATTICE AT THE RDE USING SRAC2006 MODULE OF PIJ.....	296
<i>J Susilo, I Husnayani, A A Waskita, Zuhair, S Bakhri</i>	
THE DEVELOPMENT OF TRIAC-BATAN: A TRISO FUEL PERFORMANCE ANALYSIS CODE.....	306
<i>A. A. Waskita, T. Setiadipura</i>	
BURNUP CALCULATION STUDY OF PEBBLE BED EQUILIBRIUM CORE.....	315
<i>L. Suparlina, T. Setiadipura, Suwoto</i>	
ESTIMATION OF RADIOACTIVITY IMPACT FOR RDE BASED ON HTR-10 HYPOTHETICAL ACCIDENT - A CASE STUDY.....	324
<i>P M Udiyani, S Kuntjoro, I Husnayani, M Budi Setiawan, S A Santa</i>	
PRELIMINARY ANALYSIS OF DOSE RATES DISTRIBUTION OF EXPERIMENTAL POWER REACTOR 10 MW USING MCNP	331
<i>Amir Hamzah, Suwoto, Hery Adrial</i>	

COMPARISON ON TWO OPTION DESIGN OF THE RDE COGENERATION SYSTEM	338
<i>Sukmanto Diby, Ign.Djoko Irianto, Syaiful Bakhri</i>	
ANALYSIS OF HYDROCYCLONE AS RIVER WATER PRE-TREATMENT FOR TERTIARY COOLANT OF RDE	344
<i>Sriyono, Rahayu Kusmastuti, Sofia L. Butarbutar, Djati Hoesen Salimy, Febrianto, Ign. Djoko Irianto, M. Pancoko, Geni R. Sunaryo</i>	
THE ANALYSIS FOR PREDICTION OF A CENTRAL DISTRIBUTION CRACK FOR RDE PRESSURE VESSEL BY FUZZY NEURAL NETWORK	353
<i>Mike Susmikanti, Roziq Himawan, Jos Sulisty</i>	
TWO DIMENSIONAL PERFORMANCE ANALYSIS OF SMALL HTR RESIDUAL HEAT REMOVAL SYSTEM IN DLOFC CONDITION	363
<i>Hendro Tjahjono, Susyadi, Surip Widodo, Anhar R. Antariksawan, Andi Sofrany, Hadi Kusuma, Rahayu Kusumastuti</i>	
DECOMPOSED FUNCTIONAL BEHAVIOR OF HELIUM PURIFICATION SUPPORT SYSTEM FOR EXPERIMENTAL POWER REACTOR (RDE) TYPE USING SEQUENCE DIAGRAM	372
<i>Kussigit Santosa, Restu Maerani, Sudarno</i>	
EFFECT OF HEAT ON COATING PROCESS OF JOINT TUBE WALL ASCENDING TUBE FUEL HANDLING SYSTEM RDE	377
<i>Andryansyah, Alim Mardhi, Mudi Haryanto, Darlis, Ari Nugroho</i>	
EFFECT OF SUPERHEATED STEAM PRESSURE ON THE PERFORMANCE OF RDE ENERGY CONVERSION SYSTEM	384
<i>Ign. Djoko Irianto, Sriyono, R. Kusumastuti, K. Santoso, H. Subiyah, A. Citra, S. Diby, Zuhair, S. Bakhri, G. R. Sunaryo</i>	
SOFTWARE REQUIREMENT ANALYSIS FOR DIGITAL BASED REACTOR PROTECTION SYSTEM OF RDE DESIGN	394
<i>S. Santoso, Sudarno, R. Maerani, J. Situmorang, A. Cahyono</i>	
ANALYSIS OF AIR DISTRIBUTION AT MOLECULAR SIEVE VESSEL IN RDE SYSTEM BASED ON FAN FLOW RATE VARIATION USING AEROSOL DENSITY TESTING FACILITY	402
<i>Ainur Rosidi, G. Bambang Heru, Dedy Haryanto</i>	
STUDY OF STRUCTURE SYSTEMS AND COMPONENTS CLASSIFICATION OF REAKTOR DAYA EKSPERIMENTAL - RDE BASED ON LIFE CYCLE MANAGEMENT	408
<i>Endiah Puji Hastuti, Sri Sudadiyo, Syaiful Bakhri</i>	
SENSITIVITY OF HEAT TRANSFER PARAMETERS ON THE REAKTOR DAYA EKSPERIMENTAL - RDE CORE	419
<i>Sudarmono, Suwoto, Syaiful Bakhri</i>	
CALCULATION OF DOMESTIC RAW MATERIALS USING DOMESTIC RESOURCE COST METHOD	427
<i>Arief Tris Yuliyanto, Dharu Dewi, Ewitha Nurulhuda, Nurlaila, Moch. Djoko Birmano, Utomo, Muhammad Subhan, Putut Hery Setiawan, Krismawan, Edi Siswanto, Citra Candranurani, Sufiana Solihat, Rustama</i>	
RECENT STATUS OF PUBLIC RESPONSE TO RDE DEVELOPMENT & UTILIZATION	435
<i>Dimas Irawan, Theresia Erni Wijayanti, Mudjiono, Muhammad Busthomi</i>	
SOCIAL ENGINEERING TO THE DEVELOPMENT PLAN OF EXPERIMENTAL POWER REACTOR (RDE)	441
<i>Mudjiono, Siti Alimah, Dimas Irawan, M. Busthomi, Heni Susiati</i>	
CHAIN AND SPROCKET ANALYSIS OF CONTROL ROD DRIVE MECHANISM OF HTGR EXPERIMENTAL POWER REACTOR	448
<i>M. Awwaluddin, Sri Hastuty, Z. Petrus, H. S. Putut, Krismawan, S. Edi, E. Byan W. R, A. Nugroho</i>	
THE METHODS OF CONDITION MONITORING FOR CIRCULATOR OF HTGR	455
<i>S. Bakhri, N. Ertugrul, Wen. L. Soong</i>	
PRELIMINARY EXPERIMENT OF U-SHAPED HEAT PIPE AS PASSIVE COOLING SYSTEM IN HIGH TEMPERATURE GAS-COOLED REACTOR COOLING TANK	466
<i>Mukhsinun Hadi Kusuma, Anhar Riza Antariksawan, Giarno, Sri Ismarwanti, Mulya Juarsa, Dedy Haryanto, Surip Widodo, Tanti Ardiyati</i>	
CONCEPTUAL DESIGN OF INDONESIA EXPERIMENTAL POWER REACTOR COUPLED WITH DESALINATION UNIT	475
<i>Erlan Dewita, Teguh Ariyanto, Heni Susiati, Marliyadi Pancoko</i>	
DESIGN OF REINFORCED CONCRETE SHEAR WALL OF REACTOR BUILDING, EXPERIMENTAL POWER REACTOR	483
<i>Hadi Suntoko, Eko Rudi Iswanto, Ary Marwanto, Antonius Mahatma Puteraka</i>	
PERCEPTION STUDY OF SAFETY INDICATORS IN NUCLEAR INSTALLATIONS USING MANN WITHNEY NONPARAMETRIC STATISTIC TECHNIQUE	493
<i>J. Situmorang, S. Santoso</i>	

SENSITIVITY OF REFLECTOR ON NEUTRONIC PARAMETER FOR CONVERSION CORE DESIGN OF THE TRIGA RESEARCH REACTOR	501
<i>S. Tukiran, Pinem Surian, Bakhri Syaiful</i>	
AN IMPROVEMENT OF THE DECISION MAKING GRID MODEL IN FAILURE- BASED MAINTENANCE ON RSG-GAS SYSTEM/COMPONENTS.....	511
<i>Entin Hartini, Muhammad Subekti</i>	
STUDY ON PITTING CORROSION OF ALMG₂ IN SOLUTION CONTAINING CHLORIDE.....	522
<i>Febrianto, Sriyono, Endiah Puji Hastuti, Geni Rina Sunaryo</i>	
THE DEVELOPMENT OF HTGR-TRISO COATED FUELS IN THE GLOBE: CHALLENGING OF INDONESIA TO BE AN HTGR FUEL PRODUCER.....	529
<i>T Taryo, I Husnayani, RM Subekti, S Sudadiyo, E Saragi, Rokhmedi</i>	
ASSESSMENT OF RELAP5 CODE MODEL TO SIMULATE U-SHAPED HEAT PIPE PERFORMANCE FOR HEAT SINK.....	545
<i>Anhar R. Antariksawan, Mukhsinun Hadi Kusuma, Surip Widodo, Giarno, Mulya Juarsa, Hendro Tjahyono, Dedy Haryanto</i>	
OVERVIEW OF THE APPLICATION OF THE SPECIFIC SAFETY REQUIREMENTS TO BATAN RESEARCH REACTORS	551
<i>Iman Kuntoro, Sriyono, M. Subekti, G.R. Sunaryo, Agus Rokhim, Taxwim, Jaja Sukmana</i>	
PWR FUEL MACROSCOPIC CROSS SECTION ANALYSIS FOR CALCULATION CORE FUEL MANAGEMENT BENCHMARK	558
<i>S. Pinem, T.M. Sembiring, Tukiran Surbakti</i>	
HEAT REMOVAL ANALYSIS IN THE AP1000 REACTOR'S REFUELLING PROCESS.....	574
<i>Muh. Darwis Isnaini, M. Subekti</i>	
FAST DEFECT DETECTION ON PRIMARY PUMP PIPE FOR RSG-GAS REACTOR USING ACOUSTICS EMISSION TECHNIQUES.....	582
<i>Rokhmedi, M. Yahya, Santosa Pujiarta, Syaiful Bakhri, R. Muhammad Subekti</i>	
A REVIEW ON PNEUMATIC TRANSPORTATION IN THE DESIGN OF FUEL HANDLING SYSTEM IN RDE-HTGR	590
<i>K Widiyati, Sukmanto Dibyo</i>	
UTILIZATION OF HTGR FOR PHOSPHATE FERTILIZER PRODUCTION AND URANIUM RECOVERY	597
<i>Djati H Salimy, Abdul Hafid, Sriyono</i>	
PROBABILISTIC SAFETY ANALYSIS FOR ASSESSING THE FAILURE OF HEAT REMOVAL CONTROL OF AP1000	605
<i>D T Sony Tjahyani, J H Purba</i>	
SUSTAINING THE OPERABILITY AND SAFETY OF MALAYSIAN RESEARCH REACTOR TO SUPPORT NATIONAL NUCLEAR RESEARCH AND EDUCATION	615
<i>M.F. Abd Farid, N. Ramli, M. F. Zakaria, A. N. Ab Rahim, A. S. Ligam</i>	
SIMPLE SIMULATION USING COUPLING BETWEEN FLOWNEX AND LABVIEW SIMULTANEOUSLY IN CASE OF INDONESIAN EXPERIMENTAL POWER REACTOR	622
<i>A. S. Muksin, B. Syaiful</i>	
PRELIMINARY INVESTIGATION ON NATURAL CIRCULATION FLOW USING CFD AND CALCULATION BASE ON EXPERIMENTAL DATA PRE-FASSIP-02.....	627
<i>Mulya Juarsa, Anhar R. Antariksawan, Mukhsinun Hadi Kusuma, Nandy Putra, Pryawrata Putera Moniaga</i>	
PRELIMINARY STUDY ON FLUID DYNAMICS IN MANIFOLDS OF THE REACTOR CAVITY COOLING SYSTEM – THE EXPERIMENTAL POWER REACTOR TEST FACILITY	634
<i>Arif Adtyas Budiman, Dedy Haryanto, Muhammad Subekti, Mukhsinun Hadi Kusuma</i>	
ROLE OF SENSORS (NANO) IN NUCLEAR TECHNOLOGY	645
<i>Murthy Chavali Yadav</i>	
EQUILIBRIUM CORE DESIGN OF REAKTOR DAYA EKSPERIMENTAL	650
<i>T Setiadipura, Suwoto, Zuhair</i>	
3D MODELLING AND STATIC STRUCTURAL ANALYSIS OF BOTTOM REFLECTOR EXPERIMENTAL POWER REACTOR (RDE) USING SOLIDWORKS SOFTWARE.....	658
<i>Farisy Yogatama Sulisty, Ari Nugroho, Syaiful Bakhri</i>	
CRITICALITY AND BURNUP STUDY ON DIFFERENT TRISO MODELLING OF HTR PEBBLE	665
<i>L Wahid, T Setiadipura, Zuhair, Suwoto, S Bakhri</i>	
THE SELECTION OF GEOMETRY AND FLOW RATE ON THE FLUIDIZED BED REACTOR FOR COATING PARTICLE	681
<i>R Sukarsono, S Riyadi, D Husnurrofiq, Sri Rinanti</i>	
APPLICABLE STANDARD DOCUMENT REFERENCES FOR AGEING MANAGEMENT ISSUES RELATED TO INDONESIAN RESEARCH REACTORS	695
<i>Restu Maerani, Eric Yee</i>	

MATERIAL SCIENCE AND ENGINEERING

EXTRACTION OF NEODYMIUM (III) FROM NEODYMIUM CONCENTRATE USING SYNERGISTIC SOLVENT D2EHPA, TOPO AND TBP	702
--	-----

Moch Setyadji, Suyanti

PART 2

LOW CYCLE FATIGUE PROPERTIES OF EXTRUDED 6061-T6 ALUMINUM ALLOY	710
--	-----

M Badaruddin, Zulhanif, H Supriadi

SEPARATION OF CE, LA AND ND IN RARE EARTH HYDROXIDE (REOH) BY OXIDATION WITH POTASSIUM PERMANGANATE AND PRECIPITATION	716
--	-----

M V Purwani, K Trinopiawan, H Poernomo, Suyanti, N D Pusporini, R A Amiliana

ANALYSIS OF COMPOSITION, DENSITY, AND THERMAL PROPERTIES OF U-ZR-NB ALLOY POWDER FOR NUCLEAR FUEL	729
--	-----

Masrukan, Yanlinastuti, M.H Alhasa, Arif Sasongko

INFLUENCE OF HOOKED-ENDSTEEL FIBERS ON FRESH AND HARDENED PROPERTIES OF STEEL FIBER REINFORCEMENT SELF-COMPACTING CONCRETE (SFRSCC)	737
--	-----

Faiz Sulthan, Saloma

ANALYSIS OF FATIGUE LIFE AND CRACK PROPAGATION CHARACTERIZATION OF GRAY CAST IRON UNDER NORMALIZING PROCESS	748
--	-----

Hendri Chandra, Nukman, Baoadi Sianturi

FINITE ELEMENT FAILURE ANALYSIS ON 34CRNIMO6 FIRING PIN IN FATIGUE FRACTURE	757
--	-----

A Yusup, A Mataram, I Yani, M Zahir

EVALUATION PAVEMENT DETERIORATING CONDITION ON SURFACE DISTRESS INDEX (SDI) DATA USING RADIAL BASIS FUNCTION NEURAL NETWORKS (RBFNN)	763
---	-----

Amrina Rosada, Joni Arliansyah, Erika Buchari

STUDY ON THE MECHANISM OF CO₂ ADSORPTION PROCESS ON ZEOLITE 5A AS A MOLECULAR SIEVE IN RDE SYSTEM: AN INFRARED INVESTIGATION	770
--	-----

R. Kusumastuti, Sriyono, M. Pancoko, S.L. Butar-Butar, Guntur Eko Putra, Hendro Tjahjono

CONSIDERATIONS OF MATERIAL SELECTION FOR CONTROL ROD DRIVE MECHANISM OF REAKTOR DAYA EKSPERIMENTAL	778
---	-----

Sri Hastuty, Petrus Zacharias, M Awwaluddin, Krismawan, Putut Hery Setiawan, Edy Siswanto, Budi Santoso, Ari Nugroho, Ahmad Majdi Abdul-Rani

ANALYSIS OF RPV STRENGTH IN CURRENT RDE BASED ON TEMPERATURE	786
---	-----

E. Saragi, S. Sudadiyo, T. Taryo

PREPARING THE CARBON-BASED MATERIAL WITH DIFFERENT MILLING SETTINGS TO CHANGE THE MORPHOLOGY AND CRYSTALLINE STRUCTURE	793
---	-----

Barlin, WC Chang

EFFECTS OF SIC PARTICULATE-REINFORCED ON THE FLUIDITY AND MECHANICAL PROPERTIES OF ALUMINIUM MATRIX COMPOSITE THROUGH STIR CASTING ROUTE	801
---	-----

Gunawan, Amir Arifin, Yani Irsyadi, Bembi Aris Munandar

THE INFLUENCES OF CATALYST COMBINATION ON THE HIGH TEMPERATURE PROTON EXCHANGE MEMBRANE FUEL CELL	808
--	-----

K Sasiwimonrit, W-C Chang

MECHANICAL AND INDUSTRIAL ENGINEERING

MICRO HYDRO ELECTRIC POWER PLANT (MHEP) PROTOTYPE A STUDY OF THE EFFECT OF BLADE NUMBERS TOWARD TURBINE ROTATIONAL VELOCITY	815
--	-----

Ibnu Asrafi, M. Yerizam, Sairul Effendi, Agung Mataram

THE EFFECT OF MAGNETIC FIELD AND HEATER IN BIODIESEL FUEL LINE TOWARD TORQUE, POWER, AND FUELD CONSUMPTION OF ONE CYLINDER FOUR STROKE DIESEL ENGINE AT MAXIMUM LOAD	826
---	-----

Muhamad Sirajudin, A Husaini, Tri Widagdo, Agung Mataram

PV PANEL COOLER TO ENHANCE OUTPUT PERFORMANCE USING PERFORATED ALUMINIUM PLATE	832
---	-----

I Bizzy, L Mustafizal

OPTIMALIZATION PHYSICAL ENVIRONMENT EFFECTS ON WORK PRODUCTIVITY FOR ASSEMBLY OPERATOR WITH RESPONSE SURFACE METHODOLOGY	837
<i>M. Rosyidah, D. Oktarini, Madagaskar, Azhari</i>	
SUSTAINABLE DEVELOPMENT OF LUBRICATOR TO OPTIMIZATION PROCESS OF LUBRICATION IN WIRE ROPE SLING	847
<i>Mgs Halim, H Chandra, D K Pratiwi, M Zahir</i>	
THERMODYNAMICS PERFORMANCE EVALUATION IN COMBINED CYCLE POWER PLANT BY USING COMBINED PINCH AND EXERGY ANALYSIS	854
<i>M I Riady, D Santoso, M D Bustan</i>	
DEVELOPMENT OF IMAGE ACQUISITION SOFTWARE FOR DIGITAL RADIOGRAPH AND X-RAY CT	864
<i>Fitri Suryaningsih, Demon Handoyo, Andeka Tris Susanto</i>	
DESIGN OPTIMIZATION IN STRESS DISTRIBUTION OF FIRING PIN RIFLE BY IMPACT FORCE USING FINITE ELEMENT MODELLING	872
<i>E P Riyanto, I Yani, A Arifin, M Zahir</i>	
CHALLENGES IN TURBINE FLOW METERING SYSTEM: AN OVERVIEW	878
<i>Bunyamin, Nyayu Latifah Husni, Hasan Basri, Irsyadi Yani</i>	
MECHANICAL FRACTURE CHARACTERIZATION OF RICE KERNEL UNDER MILLING PROCESS	889
<i>H Chandra'</i>	
THE ANALYSIS OF DIMPLE GEOMETRY ON ARTIFICIAL HIP JOINT TO THE PERFORMANCE OF LUBRICATION	894
<i>Hasan Basri, A. Syahrom, A. T. Prakoso, D. Wicaksono, M. I. Amarullah, T. S. Ramadhoni, R. D. Nugraha</i>	
THE EFFECT OF THE WELDING DIRECTION ON FATIGUE CRACK PROPAGATION RATE OF WELDED SHELL KILN	904
<i>Akbar Teguh Prakoso, Irsyadi Yani, Agung Mataram, Gunawan, Hasan Basri</i>	
ANALYTICAL DESIGN OF HELICAL COIL STEAM GENERATOR FOR HOT TEMPERATURE GAS REACTOR	910
<i>B W Riyandwita, M Awwaludin, Krismawan, P Zacharias, E Siswanto, P H Setiawan, A Nugroho</i>	
FATIGUE EVALUATION OF PRESSURE VESSEL USING FINITE ELEMENT ANALYSIS BASED ON ASME BPVC SEC. VIII DIVISION 2	917
<i>P. Kadarno, D. S. Park, N. Mahardika, I. D. Irianto, A. Nugroho</i>	
APPLICATION OF RSM AND ANN IN PREDICTING SURFACE ROUGHNESS FOR SIDE MILLING PROCESS UNDER ENVIRONMENTALLY FRIENDLY CUTTING FLUID	929
<i>M Yanis, A S Mohruni, S Sharif, I Yani, A Arifin, B Khona'ah</i>	
PROCESSING OF STAINLESS STEEL (SS316L)-HYDROXYAPATITE (HA) POWDER COMPOSITE THROUGH POWDER INJECTION MOLDING	937
<i>Mohd Ikram Ramli, Abu Bakar Sulong, Norhamidi Muhamad, Andanastuti Mughtar, Amir Arifin, Seong Jin Park</i>	
MACHINABILITY ANALYSIS OF DRILLED BAMBOO FIBRE REINFORCED POLYMER (BFRP) COMPOSITE	943
<i>M F A Zaharuddin, P A A Yunos, Y Jiyounng, A S Mohruni, I Yani, M Yanis</i>	
DETECTING SKIN DEFECTS OF STAR APPLE BY USING HYPERSPECTRAL IMAGES	952
<i>Quoc Thien Pham, Nai-Shang Liou</i>	
THE FABRICATION POROUS HYDROXYAPATITE SCAFFOLD USING SWEET POTATO STARCH AS A NATURAL SPACE HOLDER	958
<i>Gunawan, Amir Arifin, Irsyadi Yani, Sufran Danar Arian</i>	
SELF-IGNITION TEMPERATURE OF PEAT	965
<i>A Taufik Arief, Nukman, Elda Elwita</i>	

ELECTRICAL SCIENCE AND ENGINEERING

ELECTRICAL DESIGN FOR HELIUM PURIFICATION AND SUPPLY SYSTEM OF RDE	973
<i>Kiswanta, E. Sumarno, K. Santosa, K. Indrakoesoema, K. Handono</i>	
ROBOT POSITION CONTROL USING ANDROID	983
<i>A S Handayani, N L Husni, A B Insani, E Prihatini, C R Sitompul, S Nurmaini, I Yani</i>	
ANALYSIS OF DIELECTRIC STRENGTH OF VIRGIN COCONUT OIL AS AN ALTERNATIVE TRANSFORMER LIQUID INSULATION	990
<i>Ansyori, Zainuddin Nawawi, M. Abubakar Siddik, Indra Verdana</i>	
ELECTRICITY LOAD SATURATION ANALYSIS FOR MAKASSAR CITY	999
<i>Yusri Syam Akil, Hendra Pachri, Saiful Mangnggenre, Yusran, Muhammad Azwal, and Jumardin</i>	

EMERGENCY POWER SUPPLY OF CONTROL ROD FOR RDE	1006
<i>Koes Indrakoesoema, Khairul Handono, Edy Sumarno, Kiswanta, Adin Sudirman</i>	
HYDROTHERMAL ECONOMIC DISPATCH USING HYBRID BIG BANG-BIG CRUNCH (HBB-BC) ALGORITHM	1014
<i>Sokun Teng, Yusri Syam Akil, Indar Chaerah Gunadin</i>	
ASSESSMENT OF INPUT PARAMETERS AND ARCHITECTURE OF RDE REACTOR PROTECTION SYSTEM	1020
<i>Sudarno, Sigit Santoso, Kussigit Santosa, Restu Maerani, Deswandri</i>	

CHEMICAL SCIENCE AND ENGINEERING

PRODUCTION OF BIODIESEL FROM WASTE COOKING OIL WITH ULTRASONIC IRRADIATION METHOD AS RENEWABLE ENERGY SOURCE	1028
<i>Agus Lukman Hakim, Martha Aznury, Jaksen M Amin</i>	
SYNTHESIS BIODIESEL FROM WASTE COOKING OIL WITH MICROWAVE IRRADIATION METHOD AS ALTERNATIVE RENEWABLE ENERGY SOURCE	1035
<i>I. Gunawan, M. Aznury, A. Husaini</i>	
1,2-PROPANEDIOL - BETAIN AS GREEN SOLVENT FOR EXTRACTING α-MANGOSTIN FROM THE RIND OF MANGOSTEEN FRUIT: SOLVENT RECOVERY AND PHYSICAL CHARACTERISTICS	1042
<i>K Mulia, Y Yoksandi, N Kurniawan, I F Pane, E A Krisanti</i>	
HYDROGEN RECOVERY FROM CH₄ – H₂ GAS MIXTURE BY ADSORPTION USING COCONUT SHELL-BASED ACTIVATED CARBON	1049
<i>M Sudibandriyo, N A Madiadipura</i>	
THE COMBINED PROCESS OF PYROLYSIS AND CATALYTIC CRACKING OF RICE STRAW USING ZSM-5 AND γ-AL₂O₃ CATALYST PREPARED BY PHYSICALLY MIXING	1056
<i>Aji S Nugraha, RM Ivan Pratama, Setiadi, T S Utami</i>	
EFFECT OF HIGH SPEED HOMOGENIZER SPEED ON PARTICLE SIZE OF POLYLACTIC ACID	1065
<i>K Mulia, A Safiera, I F Pane, E A Krisanti</i>	
TREATMENT OF TOFU INDUSTRY'S WASTEWATER USING COMBINATION OF OZONATION AND HYDRODYNAMIC CAVITATIONS METHOD WITH VENTURI INJECTOR	1070
<i>E F Karamah, A R Primasto, R R Najeges, S Bismo</i>	
FORMULATION, CHARACTERIZATION, AND RELEASE PROPERTY OF ANTIOXIDANT SUPPLEMENT CAPSULE WITH RED GINGER OLEORESIN EXTRACT-LOADED CHITOSAN MICROPARTICLES	1080
<i>K Mulia, U Y Risqi, I F Pane, E A Krisanti</i>	

GEOLOGICAL SCIENCE AND MINING ENGINEERING

IDENTIFICATION OF SANDSTONE LAYER BENEATH THE DEMONSTRATION DISPOSAL SITE AT NUCLEAR SERPONG AREA USING RESISTIVITY GEO-ELECTRICAL METHOD	1090
<i>Sucipta, Bella Septian Lestari, Risdiana Setiawan, Sutrisno</i>	
THE EFFECT OF HEAT TREATMENT ON FATIGUE TESTING OF ALUMINUM CANS	1100
<i>MS Firdaus, Nukman, Irsyadi Yani, Amir Arifin, Prana Arifita, Indra Surya</i>	

ARCHITECTURE AND CIVIL ENGINEERING

EFFECTS OF THE DESIGN PARAMETERS AGAINST SLAB ON GRADE VOLUME USING CORPS OF ENGINEERING DESIGN METHOD	1106
<i>Muhamad Taufik Costarico, Maulid Muhammad Iqbal, Joni Arliansyah</i>	
ANALYZE OF TANJUNG API-API FERRY PORT SERVICE PERFORMANCE SOUTH SUMATERA, INDONESIA	1116
<i>Yossy Marissa, Maulid Muhammad Iqbal, Ika Juliantina</i>	
STRUCTURING OF SLUM SETTLEMENT INFRASTRUCTURE KERTAPATI VILLAGE, PALEMBANG CITY, SOUTH SUMATRA	1126
<i>Ariezki Yuliani, Maulid Muhammad Iqbal, Heni Fitriani</i>	

AN ANALYSIS OF AIR QUALITY THROUGH THE BASIS OF TRAFFIC PERFORMANCE OF SIGNALIZED INTERSECTIONS.....	1140
<i>Emelda Raudhati, Joni Arliansyah, Erika Buchari</i>	
ANALYSIS OF THE INFLUENCE OF TRAFFIC FLOW ON AIR POLLUTION AT SIMPANG ANGKATAN 66 OF PALEMBANG CITY.....	1149
<i>Mei Lisa Adha, Joni Arliansyah, Erika Buchari</i>	
IDENTIFICATION OF DAMAGED INFRASTRUCTURE ON SHEET PILE MUSI AT PALEMBANG CITY.....	1157
<i>Ratih Baniva, Maulid M. Iqbal, Heni Fitriani</i>	
CHANGE OF ELEMENT SETTLEMENT IN MUSI RIVERSIDE PALEMBANG.....	1162
<i>Bambang Wicaksono, Ari Siswanto, Susilo Kusdiwanggo, Widya Fransiska Febriati Anwar</i>	
RELIABILITY ANALYSIS OF SAFETY SYSTEM ON FIRE HAZARD FACTORY BUILDING (STUDY CASE AT PT. SEMEN BATURAJA).....	1170
<i>Dewi Marlina, Heni Fitriani, Ika Juliantina</i>	
DEVELOPMENT OF MAINTENANCE SYSTEM PROCEDURE GOVERNOR OFFICE BUILDING SOUTH SUMATERA PROVINCE.....	1176
<i>Andriansyah, Maulid Iqbal, Mona Foralisa</i>	
STUDY ON DEVELOPMENT OF WATER SUPPLY SYSTEM IN PENUKAL ABAB LEMATANG ILIR REGENCY.....	1188
<i>Rina Anggraini, Maulid Muhammad Iqbal, Sarino</i>	
DETERMINING RENT PRICE OF KASNARIANSYAH FLAT USING ABILITY TO PAY ANALISYS.....	1196
<i>F H Putri, M M Iqbal, I Juliantina</i>	
THE SPATIAL DECISION-MAKING SYSTEM IN MITIGATION OF THE SOUTHERN RING ROAD OF INUNDATION SUB WATERSHEDS.....	1206
<i>Tezar Rizky Abdullah, Dinar DA Putranto, Sarino</i>	
ANALYSIS OF OPEN GREEN SPACE IN THE AREA OF SRIWIJAYA UNIVERSITY INDRALAYA.....	1218
<i>Aries Sandratama, Dinar Dwi Anugerah Putranto, Sarino, Ari Siswanto</i>	
THE INFLUENCE OF OPERATION AND MAINTENANCE ACTIVITIES ON WATER MANAGEMENT OF TINONDO SWAMPS IRRIGATION AREA AT EAST KOLAKA REGENCY, SOUTHEAST SULAWESI PROVINCE, INDONESIA.....	1229
<i>Hesti Wahyu Lestari, Dinar Dwi Anugerah Putranto, Sarino</i>	
THE FINANCIAL FEASIBILITY ON DEVELOPING TERMINAL BUILDING OF SULTAN MAHMUD BADARUDDIN II INTERNATIONAL AIRPORT.....	1236
<i>M Oktari, M M Iqbal, M Agustien</i>	
ANALYSIS OF FLOOD HYDROGRAPH TO THE LAND USE CHANGE ON FLOOD PEAK DISCHARGE IN THE SEKANAK WATERSHED.....	1244
<i>Soraya Ayu Lestari, Dinar Dwi Anugerah, Sarino</i>	
HEALTH AND SAFETY ANALYSIS OF LIGHT RAIL TRANSIT PROJECTS IN PALEMBANG.....	1254
<i>Gafo Rudy Hendrik Aji, Dinar DA Putranto, Ika Juliantina</i>	
MECHANICAL PROPERTIES OF FOAMED CONCRETE WITH ADDITIONAL PINEAPPLE FIBER AND POLYPROPYLENE FIBER.....	1260
<i>T Irawan, Saloma, Y Idris</i>	
AN ANALYSIS OF THE DAMAGE AND ESTIMATED MAINTENANCE COSTS A. ROZAK STREET CITY OF PALEMBANG.....	1267
<i>Bayumi Oktorine, Dinar Da Putranto, Ika Juliantina</i>	
CHARACTERISTICS FOAM CONCRETE WITH POLYPROPYLENE FIBER AND STYROFOAM.....	1275
<i>Falfuady, Saloma, Y Idris</i>	
MECHANICAL PROPERTIES OF FLY ASH-BASED GEOPOLYMER WITH NATURAL FIBER.....	1282
<i>R Zulfiati, Saloma, Y Idris</i>	
EVALUATION OF DESIGN PLANNING WATER DISTRIBUTION SYSTEM WITH WATERCAD V.7.0 SIMULATION PROGRAM FOR TOWNSITE BASECAMP SETTLEMENT RELOCATION IN TANJUNG ENIM, SOUTH SUMATRA.....	1289
<i>Eka Septiawati, Edy Sutriyono, Ika Juliantina, Ari Siswanto</i>	
THE ANALYSIS OF ABILITY TO PAY (ATP) AND WILLINGNESS TO PAY (WTP) ON LIGHT RAIL TRANSIT (LRT) TARIFF IN PALEMBANG.....	1299
<i>M. H. A. Sarwandy, Joni Arliansyah, Heni Fitriani</i>	
EXPERIMENTAL STUDY OF MODEL IN FOLDED PLATE SOFT CLAY.....	1308
<i>Evin Oktavina, Maulid Iqbal, Ratna Dewi</i>	

ANALYSIS OF TRIP ATTRACTION AS LAND USE DEVELOPMENT EFFECT IN PALEMBANG: CASE STUDY ON CINDE TRADITIONAL MARKET	1315
<i>Marice Agustini, Erika Buchari, Melawaty Agustien</i>	
EFFICIENCY ANALYSIS OF SUBAN IRRIGATION SYSTEM, WEST TANJUNG JABUNG, JAMBI PROVINCE	1321
<i>Achmad Rezhani Fitra, Dinar DA Putranto, Sarino</i>	
WATER MANAGEMENT PLANNING FOR SWAMP BUFFALO IN SUB-DISTRICT RAMBUTAN, BANYUASIN REGENCY	1326
<i>Andre Wibowo, Dinar Dwi Anugerah Putranto, Sarino</i>	
ROLE ANALYSIS AND MANDOR FUNCTIONS ON BRIDGE AND BUILDING CONSTRUCTION PROJECTS IN DISTRICT OGAN KOMERING ULU.....	1333
<i>R Vrayudha, M Iqbal, M Foralisa</i>	
THE BUILDING PERFORMANCE OF LIMAS HOUSE; DEALING WITH CURRENT CONTEXT	1346
<i>Widya Fransiska F Anwar</i>	
ANALYSIS OF AIR POLLUTION DUE TO VEHICLE EXHAUST EMISSIONS ON THE ROAD NETWORKS OF BERINGIN JANGGUT AREA.....	1354
<i>Achmad Rizki Pratama, Joni Arliansyah, Melawaty Agustien</i>	
ANALYSIS AND DESIGN OF CRANE BEAM OF EXPERIMENTAL POWER PLANT TURBINE BUILDING	1368
<i>Abdul Hafid, Djati Salimi, Ewitha, Sitti Hijraini Nur</i>	

COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

RICE FARMING AGE DETECTION USE DRONE BASED ON SVM HISTOGRAM IMAGE CLASSIFICATION.....	1376
<i>Marsujitullah, Zahir Zainuddin, Salama Manjang, Aksan Surya Wijaya</i>	
A COMPARATIVE STUDY OF THE ALGORITHMS FOR PATH FINDING TO DETERMINE THE ADVERSARY PATH IN PHYSICAL PROTECTION SYSTEM OF NUCLEAR FACILITIES	1383
<i>D. Andiwijayakusuma, A. Mardhi, I. Savitri, T. Asmoro</i>	
AN APPROACH IN AUTO VALUING FOR OPTIMAL THRESHOLD OF VIOLA JONES	1388
<i>Indrabayu, Nurzaenab, Ingrid Nurtanio</i>	
STUDY IN DEVELOPMENT OF CANS WASTE CLASSIFICATION SYSTEM BASED ON STATISTICAL APPROACHES	1397
<i>Y Resti, A.S. Mohruni, T. Rodiana, D.A. Zayanti</i>	
PERSONAL IDENTIFICATION USING VOICE RECOGNITION WITH NEURO FUZZY METHOD	1402
<i>Ariyawan Sunardi, Rezky Mahardika, Sunarko, Heri Suherkiman</i>	

FOOD AND AGRICULTURAL SCIENCE, NATURAL RESOURCE SCIENCE

IDENTIFICATION OF SETTLEMENT IN THE AREA SITE RDE AND IT'S SURROUNDING FOR SOCIAL ENGINEERING EVALUATION.....	1412
<i>Heni Susiati, Habib Subagio, Mudjiono, Siti Alimah, Dimas Irawan</i>	
Author Index	

Synthesis Biodiesel from Waste Cooking Oil with Microwave Irradiation Method as Alternative Renewable Energy Source

I. Gunawan^{1*}, M. Aznury¹, A. Husaini²

¹Applied Magister Student-Renewable Energy Engineering Program
State Polytechnic of Sriwijaya (Palembang - Indonesia)

²Lecturer of Applied Masters Program - Renewable Energy Technique of Politeknik
Negeri Sriwijaya (Palembang - Indonesia)

*E-mail : bigopro@yahoo.com

Abstract. Biodiesel is a very potential fuel to replace diesel fuel. WCO can be used as raw material for making biodiesel. One method of making biodiesel is by using microwave irradiation. Microwave heating is more advantageous than conventional method heating, because conventional method heating is very slow and inefficient. This study aims to determine the effect of power, reaction time and physical properties of raw materials in the manufacture of biodiesel from waste cooking oil using microwave irradiation. The experimental stage consists of pretreatment, transesterification, separation, washing, and analysis of biodiesel yields. Transesterification of waste cooking oil takes place in a microwave oven by: (a) variations in microwave power (100, 180, 300, 450, and 600 Watt) at 5 min, and (b) reaction time variation (5, 10, 15, 20 and 25 minutes) at a fixed power of 100 Watt. From the research it is known that the operating conditions to produce the best yield of biodiesel yield on 100 watt microwave power and heating time for 10 minutes. The yield of biodiesel is 93.06%. The laboratory analysis results show five methyl ester compounds (biodiesel) such as methyl myristate, methyl palmitate, methyl linoleate, methyl oleate, and methyl stearate. The physical properties of biodiesel produced have met several criteria of Dirjen Migas no 13483K / 24 / DJM / 2006 for biofuel / biodiesel and SNI 04 - 7182 (2012).

Keywords: biodiesel; physical properties; microwaves; waste cooking oil ; transesterification

1. Introduction

Background

The fossil diesel fuel reserves are depleted and will eventually run out. Biodiesel has the potential to replace diesel fuel, as it can be made from renewable sources, vegetable oils or animal oils. The advantages of using alternative fuels are better emissions, biodegradability, and do not contribute to increasing atmospheric CO₂ levels [1]

Biodiesel has several distinct advantages over diesel in the following aspects of security, biodegradability, and environment [2]:

- Renewable fuels with net energy gains to produce them
- Higher flashes that make it safer to transport and store
- Greatly reduces particulate emissions and carbon monoxide
- Reducing Polycyclic Aromatic Hydrocarbons (PAHs) and nitration carcinogenated
- Basically does not contain sulfur, thereby greatly reducing sulfur dioxide emissions from diesel vehicles
- Can decompose as soon as dextrose

Waste cooking oil is often used for frying repeatedly, even until the color is dark brown or black and then discarded. The use of waste cooking oil repeatedly is very dangerous for health. In its use,



waste cooking oil undergoes chemical changes due to oxidation and hydrolysis, which can cause damage to the waste cooking oil.

To overcome this, waste of used waste cooking oil (jelantah) can be used as raw material for making biodiesel [3]. Transesterification is a reversible reaction, in which triglycerides change completely into diglycerides, monoglycerides, and finally become glycerin. Stoichiometrically, 3 moles of alcohol is required for 1 mole of triglyceride, but in practice a greater comparative ratio is required to shift the equilibrium resulting in more esters. The transesterification reaction converts triglycerides (96-98% oil) and alcohol to ester, with residual glycerine as a by-product. The result is long and branched triglyceride molecules converted into smaller esters having similar size and properties to diesel oil.

Alcohols used are short chain alcohols, such as methanol, ethanol and butanol. Methanol and ethanol can be easily produced from vegetable materials. Ethanol produces less ethyl ester and leaves a lot of carbon residue. Methanol in addition to its cheaper price, is also the most commonly used type of alcohol. The catalyst is used to speed up the course of the reaction [4].

Methanol and ethanol are the most widely used types of alcohols in the industry, since both types of alcohols give relatively faster reactions. Reactions with alcohols having lower boiling points are carried out at 70-85 °C, whereas for reactions with high boiling alcohols it is carried out at a temperature of 200-250°C. The reactor used is cultivated in a dry state and the free fatty acid content present in the oil or fat should be small. The catalyst concentration will be reduced because water and free fatty acids will react with the alkaline catalyst and form the soap.

Methanolysis with 1% by weight of potassium hydroxide (KOH) yields the best conversion with the highest yield and excellent biodiesel viscosity [5]. Stoichiometric reactions require 1 mole of triglyceride and 3 moles of alcohol. However, excess alcohol is used to increase the yield of the alkyl ester and facilitate the phase separation of the formed glycerol [6]. The optimum molar ratio of methanol / oil is 6: 1 [5].

The entire transesterification reaction can be written as follows [7] :

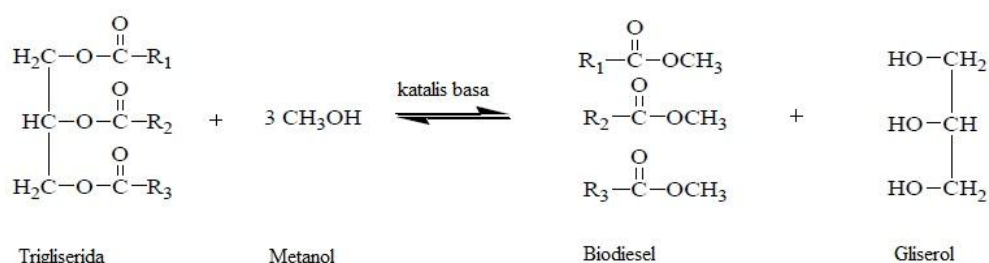


Figure 1. Transesterification Reactions [6]

When the transesterification process has been widely used and becomes important, there are some inefficiency considerations in current transesterification roses. In conventional heating for the transesterification process (batch process, continuous, and supercritical methanol), heat energy is transferred by convection, conduction, and radiation from the surface to the feedstock. Thus, conventional heating consumes more energy and takes longer for preheating and reaction, optimally 1 hour to produce 95% biodiesel yield.

One alternative energy, "microwave irradiation" can be used for the transesterification process. In the spectrum of electromagnetic radiation, the area of microwave radiation lies between infrared radiation and radio waves. Microwaves have a wavelength of 1 mm - 1 m with frequencies between 0.3 - 300 GHz. In general, to avoid interference, microwave equipment is usually set with a 12.2 cm wavelength with a frequency of 2.45 GHz [8]. Microwave heating is more advantageous than conventional method heating, where heating is very slow and inefficient because the transfer of energy to the material depends on the convection currents and the thermal conductivity of the reaction mixture [5]

When the conventional transesterification process takes 75 minutes, the process with a microwave takes only 4 minutes. At the percentage increase in power, in the same time, the number of conversions obtained is somewhat constant. The use of the microwave transesterification process dramatically reduces the reaction time from 75 minutes to 4 minutes, (at 60 °C) so it saves time. The irradiation time should be controlled to avoid overheating which can destroy some organic molecules. Radiation power levels should not be too high, which can cause damage to organic molecules [2]

Some examples of transesterification methods using microwave irradiation have been performed both batch and continuous. Leadbeater and Stencel have reported the use of microwaves as a quick and simple way of making biodiesel [9]. In this research, biodiesel is made by using batch micro wave.

2. Research methodology

Time And Place Of Research

The research has started from June 2017 until April 2018 with the following stages:

- a. Literature studies, discussions and consultations related to topic plans and research titles to be discussed (biomass, biodiesel, new and renewable energy sources).
- b. The design of the test equipment is carried out in the Workshop of Engineering & Maintenance Engineering Department of Engineering Polytechnic Negeri Sriwijaya Palembang.
- c. Testing, equipment performance test conducted at Energy Conversion Laboratory of Energy Engineering Department Department of Chemical Engineering State Polytechnic of Sriwijaya Palembang and Refinery Unit 3 Pertamina Plaju Laboratory.

Time And Place Of Research

The research has started from June 2017 until April 2018 with the following stages:

- a. Literature studies, discussions and consultations related to topic plans and research titles to be discussed (biomass, biodiesel, new and renewable energy sources).
- b. The design of the test equipment is carried out in the Workshop of Engineering & Maintenance Engineering Department of Engineering Polytechnic Negeri Sriwijaya Palembang.
- c. Testing, equipment performance test conducted at Energy Conversion Laboratory of Energy Engineering Department Department of Chemical Engineering State Polytechnic of Sriwijaya Palembang and Refinery Unit 3 Pertamina Plaju Laboratory.

Materials and Research Methods

The materials used in this research are walnut oil, activated carbon, methanol (96%), KOH, and aquades. Waste oil obtained from waste cooking oil used stalls around the campus. KOH, hydrochloric acid and sulfuric acid are obtained from Merck. The sterile distilled water is obtained from PT Ikapharmindo. The methanol used has a 96% purity obtained from Brataco Chemika. The main tools used are microwave oven, separator funnel, and magnetic stirrer.

Initial treatment stage

The experiment begins with a bleaching process of waste cooking oil by heating at 70°C with stirring for 1 hour with 7% by weight of activated carbon. Then the waste cooking oil is filtered with filter paper to remove any remaining debris. Performed measurements of free fatty acid (FFA) in waste cooking oil.

Transesterification process

In the transesterification process, ready-to-use waste cooking oil is put into a beaker glass of 50 grams. Meanwhile, a methanol solution was prepared (methanol molar ratio: oil = 6: 1), which added a KOH catalyst of 1% by weight of waste cooking oil. Then both of them are mixed and stirred evenly in beaker glass and put into microwave oven which have previously been arranged power and time. Transesterification of waste cooking oil takes place in a microwave oven by: (a) variations in microwave power (100, 180, 300, 450, and 600 Watt) at 5 min, and (b) reaction time variation (10, 20, 30, 40 and 50 minutes) at a fixed power of 100 Watt.

The process of separation and purification

After the specified time, then the transesterification result is removed from the oven and transferred into the separation funnel. The product is idle for \pm 20 hours to form 2 layers. The top layer is

biodiesel and the bottom layer is glycerol. Then both are separated. The separated biodiesel is washed repeatedly with aquadest until the distilled water no longer contains soap and looks clear.

Product analysis

The biodiesel obtained is then weighed to obtain a yield. The biodiesel characteristic test was analyzed to determine the biodiesel physical properties based on the criteria of Director General of Oil and Gas for biodiesel.

Results and Discussion In this study, biodiesel was made using KOH catalyst (1% wt. Waste cooking oil) and 96% methanol in various heating power and heating time. From the measurement results obtained free fatty acids fatty acid level of 0.5% so that directly can be done transesterification process. Initially the yield of biodiesel obtained will increase as the power and duration of heating increases. However, when optimum heating power and time have been reached, the resulting biodiesel weight gain will decrease. From experiments that have been done we get the optimum biodiesel weight is on 100 Watt heating power and 10 minutes heating time. The results obtained are the golden yellow biodiesel at the top and glycerol are blackish red at the bottom. Once separated and purified by washing with warm aquasuns, the resulting biodiesel will be colored kuning bening.

Effect of heating power on yield (biodiesel)

Biodiesel results in various power variations with constant time can be seen in table 1 and figure 2.

Table 1. Result of Biodiesel Making Experiment with Power Variation (Watt) 5 Minutes

Power (Watt)	Weight Biodiesel (gram)	Yield (%)
100	44.60	89.20
180	41.81	83.62
300	37.63	75.25
450	32.40	54.79
600	27.17	54.33

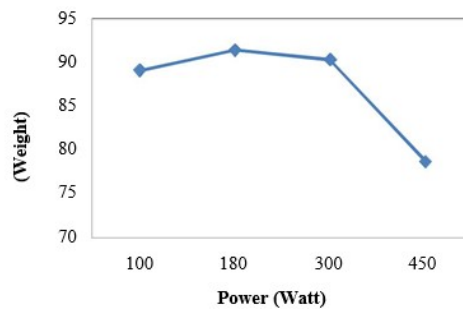


Figure 2. Graph of Power Relation (watt) with yield Biodiesel (% weight)

Based on table 1 and figure 2, the yield of biodiesel decreased to 450 watts, then decreased significantly until 600 watts of power. It is seen in this experiment that the optimum biodiesel yield obtained at 100 watts, ie 89.20%.

Influence of time of heating to yield (biodiesel)

Biodiesel yield at various time variations with constant heating power can be seen in table 2.

Table 2. Result of Biodiesel Making Experiment with Variation of Time (100 Watt Power)

Time (minute)	Weight Biodiesel (gram)	Yield (%)
10	46,46	90,00
20	42,35	84,70
30	38,24	76,40
40	34,13	68,10
50	30,02	59,80

The transesterification reaction using microwave radiation can speed up the reaction, which conventionally lasts for 1-2 hours. Most conventional transesterification processes are completed in the first 30 minutes of reaction (achieving 80% yield), then completely complete after 1 hour (yield 96.15%). By increasing the reaction time of 3 hours there is no addition of too large yield (yield 96.30%). From the results obtained, the optimum yield percentage was obtained using the molar ratio of methanol: oils of 6: 1, the catalyst used KOH (1%) and the temperature of 65 ° C for 1 hour [5].

Based on table 2 it can be seen that the effect of time is very visible at the time under 10 minutes. Before 10 minutes, the percentage of biodiesel produced is quite large compared to the time afterwards. While in the region of 10 to 20 minutes, it may be an optimum region, because after reaching a certain point, the percentage gain of biodiesel decreases again. The optimum biodiesel conversion results were obtained at 10 minutes of radiation, which was 93.00%. As the reaction continues for a longer time, the resulting biodiesel conversion results decrease with the addition of radiation time.

3. Results and Discussion

Analysis of physical properties of biodiesel

To know the biodiesel that has been produced, it is necessary to do some test of biodiesel parameters in accordance with the specification of Director General of Oil and Gas for biodiesel no 13483K / 24 / DJM / 2006 and SNI 04 - 7182 (2012). The biodiesel test includes density, viscosity, flash point, pour point, moisture content that can be seen in table 3 for WVO and table 4 for synthesis.

Table 3. Physical Properties of Biodiesel

No.	Properties	Unit	Result	Method	SNI
1	Specific Gravity at 60/60 °F	g/mL	0.9092	ASTM D 1298	0,850 - 0,890
2	Kinematic Viscosity at 40 °C	mm ² /s	8.5415	IKU/5.4/TK-02	2,3 – 6,0
3	Flash Point, PM.c.c	°C	152.0	IKU/5.4/TK-03	min. 100
4	Pour Point	°C	9	IKU/5.4/TK-04	- 15 – 10
5	Water Content	% vol.	trace	ASTM D 95	maks 0,05

Table 4. Physical Properties of Biodiesel Result of Synthesis

No.	Properties	Unit	Result	Method	SNI
1	Specific Gravity at 60/60 °F	g/mL	0.8669	ASTM D 1298	0,850 - 0,890
2	Kinematic Viscosity at 40 °C	mm ² /s	4.8810	IKU/5.4/TK-02	2,3 – 6,0
3	Flash Point, PM.c.c	°C	150.0	IKU/5.4/TK-03	min. 100
4	Pour Point	°C	9	IKU/5.4/TK-04	- 15 – 10
5	Water Content	% vol.	trace	ASTM D 95	maks 0,05

Compared with the requirements of the quality of biodiesel of the Director General of Oil and Gas and the Indonesian National Standard, in terms of density, kinematic viscosity, flash point, and pour point, have fulfilled the stipulated requirements. This biodiesel can therefore be considered as a replacement fuel or additional material for diesel.

4. Conclusion

Specific Gravity or Density is the ratio of the mass amount of a substance to its volume at a certain temperature. The lower the temperature, the biodiesel will be higher and vice versa. The presence of glycerol in biodiesel that may affect the density of biodiesel because glycerol has a high enough density (1.26 g / cm³).

Viscosity is one of the factors affecting the speed of separation of glycerol from biodiesel besides density. Glycerol is one of the compounds that can increase the viscosity of biodiesel. Visuality of the product in each of the lowest catalyst variables when the microwave power of 200 watts. This is because the greater the power will provide a large thermal effect is also characterized by rapid temperature rise. The reactants that have been converted to biodiesel and glycerol will undergo further reactions as pressure increases and temperature increases. While Flash Point does not significantly change or affect the results. Water content can be eliminated by cladding or filtering Microwave microwave (microwave) can be utilized in the manufacture of biodiesel from waste cooking oil through the transesterification process. Making biodiesel by utilizing microwaves requires a much shorter time when compared with conventional biodiesel manufacturing process. The effect of reaction time and microwave power on the product indicates that the greater the time and the heating power, the yield of the resulting product has a tendency to increase to the highest (optimum) point and then to fall back. In general, the quality of biodiesel produced has met the established standards and provisions of biodiesel (SNI). Biodiesel with the largest yield produced at reaction time 10 minutes, 100 Watt power. The optimum yield was 93.00% by weight.

Bibliography

- [1]. Suppalakpanya, K., Ratanawilai, S. B., & Tongurai, C., (2010), "Production of Ethyl Ester from Esterified Crude Palm Oil by Microwave with Dry Washing by Bleaching Earth", *Applied Energy*, 2356–2359.
- [2]. Anonim, (2006), "Standar Nasional Indonesia Biodiesel", *Badan Standardisasi Nasional, SNI 04-7182-2006*
- [3]. Saifuddin, N., & Chua, K. H., (2004), "Production of Ethyl Ester (Biodiesel) from Used Frying Oil: Optimization of Transesterification Process using Microwave Irradiation", *Malaysian Journal of Chemistry*, 077-082.
- [4]. Adhiatma, A., Anshory, C. P., Purwanto, A., & Ciptonugroho, W., (2012), "The Enhancement of Waste Waste cooking oil Esterification Catalyzed by Sulfated Zirconia and Assisted by The

- Addition of Silica Gel", *Proceeding of 19th Regional Symposium on Chemical Engineering*, Bali.
- [5]. Encinar, J. M., (1999), "*Preparation and Properties of Biodiesel from Cynara Cardunculus L. Oil. Industrial and Engineering Chemistry Research*", (Vol. 38), Washington, Ind. Chem. Res.
- [6]. Refaat, A. A., & El Sheltawy, S. T., (2008), "Time Factor in Microwave-Enhanced Biodiesel Production", *WSEAS Transactions*, Vol. 4 (4), 279-288.
- [7]. Schuchardt, U., Serchelia, R., & Matheus, R., (1998), "Transesterification of Vegetable Oils: a Review", *Journal of Brazilian Chemical Society*, Vol. 9 (1), 199-210
- [8]. Ketaren, S, (1986), "*Minyak dan Lemak Pangan*", Jakarta, UI Press.
- [9]. Lidstrom, P., Tierney, J., Wathey, B., & Westman, J., (2001), "Microwave Assisted Organic Synthesis – A Review", *Tetrahedron* , 9225-9283.
- [10]. Leadbeater, N. E., Barnard, T. M., Boucher, M. B., Stencel, L. M., & Wilhite, B. A., (2007), "Continuous-Flow Preparation of Biodiesel Using Microwave Heating", *Energy and Fuels*, 1777-1781.

SENTEN

Symposium of Emerging Nuclear
Technology and Engineering Novelty



Certificate

THIS CERTIFICATE IS PROUDLY PRESENTED TO

MARTHA AZNURY

as : participant / presenter / guest / comittee*

SENTEN 2018

Symposium of Emerging Nuclear Technology and Engineering Novelty
Palembang, 4-5th July 2018

"Discovering
Science and Engineering Novelty
for improving human life prosperity"

Head of Center for Nuclear Reactor
Technolofy and Safety

Dr. Geni R. Sunayo, M.Sc

Dean of Engineering Faculty
Sriwijaya University

Prof. Ir. Subriyer Nasir, M.S., Ph.D.