ABSTRACT BOOK

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The committee would like to welcome you to the 4th International Conference on Mechanical Engineering (ICOME 2019). This event is hosted by Department of Mechanical Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Indonesia. ICOME 2019, which is held in Yogyakarta, Indonesia on August 28th - 29th, has a theme of 'Innovative Science and Technology in Mechanical Engineering for Industry 4.0'. It aims to bring together international researchers, industrial professionals and students from the broad range of disciplines related to mechanical engineering and sciences. The intimate, collegial and stimulating ambience provided through ICOME is the perfect environment for you to discuss the current trends in mechanical science and engineering related fields.

It is our pleasure to present this Abstract Book. On behalf of the committee, we would like to thank you for your active contributions to share your findings through this conference. We would like to express our gratitude to the reviewers for their dedications, comments and suggestions hence the accepted papers have met the international journal standard. Eventually, we gratefully acknowledge the committee members, individuals and sponsors for their support in ICOME 2019.

We sincerely wish for your research and knowledge to be enriched, and enjoy your stay in Yogyakarta!

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Table of Content

Control

Design of Sliding Mode Control for Surge, Heave and Pitch Motion Control of NUSAITS AUV 14

Performance Analysis and Comparation of BLDC Controller Trapezoidal and FOC 15

Towards Intelligent and Reconfigurable Brushless Direct Current (BLDC) Motor controller 16

Short Circuit Study On Ship Dynamic Positioning System Based On Laboratory Scale Experiment 17

Earthquake Waveform Data Conversion using Seisan and Seizmo for Magnitude Study Comparison 18

Position Estimation of Touristant ASV Using Ensemble Kalman Filter 19

Design

Power Prediction of a 4-CRU Parallel Mechanism Based on Extra Gradient Boosting Regressor 21

Numerical Homogenization of Viscoelastic Composites with Elliptical Piezoelectric Fiber 22

Free Vibration Characteristics of Jute Fibre Reinforced Composite for Determination the Material Properties: Numerical and Experimental Studies 23

Biomechanical Analysis of Correction Force and Cobb Angle in Scoliotic Spine Fixation24

Effect of Contact Surface Temperature on Wear of Nickel-Chromium Layer 25

Geometric Modeling of Fore Body Surface Remotely Operated Vehicle (ROV) Observation Class 26

Numerical Study Of Heat Transfer And Stress-Strain On 2 Joints And 3 Joints Soot Blower Lance Tube At Suralaya Power Plant 27

Urban Soundscape Prediction Based On Acoustic Ecology and MFCC Parameters 28

Evaluation of Derailment Risk by Simplified Analytic Procedure and Computer Simulation 29

Design and Analysis for Vibration Assisted Micro Milling 30

Dynamic Trajectory Generation of Suspended Cable Driven Parallel Robot 31

Modification, Manufacturing, and Testing of Three Axes Load cell 32

Optimization in Airless Tires Design Using Back-Propagation Neural Network (BPNN) and Genetic Algorithm (GA) Approaches 33

Modularization of Ship Engine Room Using Design Structure Matrix (DSM) Based on The Genetic Algorithm 34

Analysis Properties of Rock Mechanics in JIIPE area, Gresik, East Java, Indonesia for Tunnel Construction using Deformation Methods in MATLAB Application 35

Power and Tractive Force Analysis of Series-Parallel Hybrid Vehicle Based on Road Test (Case Study: Toyota Prius Hybrid) 36

Power and Tractive Force Analysis of Series-Parallel Plug-in Hybrid Vehicle Based on Road Test (Case Study: Toyota Prius Plug-in Hybrid) 37

The Influence of Un-lean CNG Injection to the Material Strength of the Single Cylinder Dual Fuel Diesel Engine 38

Operator Splitting Method for Solving Anisotropic Problem 39

Topology Optimization on Geometry of 3D Printed "Impulse RC Alien 4 Inch" Racing Quadcopter Frame with Polylactic Acid Material 40

Effect of Surface Treatment and Grain Boundary Orientation to The Changes in Stents Surface Roughness 42

Analytical and Experimental Study of Translational Vibration Response's Reduction on Aluminum (Al) Drilling Process Using Translational Mass Vibration Absorber (TMVA) System 43

Optimum Value Analysis of Vibration Response Reduction in Translational, Rolling, and Pitching Direction of the Primary System and Voltage Generation by Cantilever Piezoelectric Vibration Absorber (CPVA) Mechanism 44

Hydro-Regenerative Shock Absorber with Two Generators in Series for Vehicle Suspension 45

Radial Vibration Damper (RVD) Mechanism Validation for Long Thin Shaft at Lathe Machine 46

Girder Extension Effect on Earthquake Resilience of Ship Unloader Crane: A Numerical Study 47

The Effect of Tuned Mass Damper to the Vibration of Wind Turbine Structure Model 48

Dynamic Analysis and Control of Gyroscopic Inverted Pendulum 49

Experimental and Numerical Analysis on Strengthening of 40-ft Flat Wagon 51

Ball Bearing Fault Diagnosis Using Wavelet Transform and Principal Component Analysis 52

Dynamic Analysis of Bangladesh Broad Gauge Train Using Multibody System 53

Probabilistic Assessments of Fatigue Crack Growth Rate of TIG Welded Al 6013-t4 by Weibull Distribution Function 54

Analysis and Comparison of the Potentially Recaptured Kinetic Energy from the Vehicle Braking Process of Lock and Anti-Lock Brake System 55

Simulation Study and Stress Analysis Conventional Pumping Unit Finite Element Method 56

The Effect of Surface Contact on The Stress Distribution and Deflection of Airless Tire . 57

Multi Function Wheelchair 58

Energy

Experimental and Numerical Study on The Boundary Layer Flow over a Flat Plate with a Semi-Circular Bump with and without a Transversal Wire 60

The Exergy Analysis on Energy System of AC Split Application with Capillary Tube Incorporated Ejector and Dual Evaporator Temperature 61

Numerical Study of Three-Dimensional Flow Characteristics Around the Wing Airfoil E562 With Forward and Rearward Wingtip Fence 62

Numerical Simulation Analysis of Supersonic Asymmetric Converging-Diverging Nozzle with Stepped Curvature and Curved Geometries 63

Thermodynamic Investigation of Automotive Air Conditioning System Performance Using Ejector as an Expansion Device 64

Analysis of Heat Transfer and Pressure Loss of Fluid Flow through Perforated Concave Delta Winglet Vortex Generators in a Rectangular Channel with Field Synergy Principle 65

The Study of The Aerodynamic Effect of Motorcar Rear Wing Using Computational Simulation..... 66

Effect of Natural Gas Injection Timing on Combustion Performance & Methane Slip Emission of Diesel – NG Dual Fuel Engine : an Experimental Study 67

Influence of Thermal Cycling of Cold Rolled Stainless Steel 316L onto Hardness and Microstructures 68

3D Reconstruction of Rolling Contact Fatigue Cracks in Rails with Tight Serial Cutting. 69

Friction and Wear Performance of Phosphonium-based Ionic Liquid Additives in Glycol Media 70

The Effect of Acidity and Rotation Speed in Titanium Dioxide Synthesize Process 71

Fabrication Membrane of Titanium Dioxide (TiO2) Blended Polyethersulfone (PES) and Polyvinilidene Fluoride (PVDF); Characterization, Mechanical Properties and Water Treatment 72

An Experimental Investigation of Geopolymer Composite Reinforced with by Short Carbon Fiber 73

Low Cycle Fatigue Properties of Aluminizing Coating on Cold-Drawn AISI 1018 Steel . 74

The Performance of Carbide Waste as an Adsorbent to Reduce Spark Ignition Engine Emission 75

Investigation of PEM Fuel Cell Performance Using the Bio-Inspired Flow Field Combined with Baffles on Branch Channels 76

The Experiment Study of Performance of Air Heater Solar Collectors Type Dimple Inline Plate V-Corrugated Absorber 77

The Effect of Injection Timing of Diesel Engine Using Emulsified Fuel on Engine Performances 78

Experimental Study of Performance of Scroll Type Expander in Organic Rankine Cycle (ORC) with R-141b Working Fluid 79

CFD Simulations of Complex Fluid Flow in Gas-Solid Fluidized Bed using Modified k-epsilon Turbulence Models 80

Numerical Study and Unsteady Savonius and Icewind Turbine Blade Design in FSI Method..... 81

Numerical Study of the Characteristics of Flow and Heat Transfer Design of USC 1000 MW Superheater Boiler..... 82

Influence of Water Diesel Emulsion on The Performance and Emission Diesel Engine Under Varying Engine Load..... 83

Experimental Study Effect of Classifier Pulverizer Opening Setting Variation on Fineness Production Passed 200 Mesh for Berau Coal in Unit 6 of Suralaya Steam Power Plant 84

Analysis and Optimization Of A 400 MW Coal Fired Power Plant Under A Proposed Low Rank Coal with Flue Gas Recirculation Mode..... 85

Numerical Study of Flow Characteristic and Heat Transfer on High Pressure Turbine Forced Cooling Process of PLTU Lontar..... 86

Experimental Study The effect of the variation of the Mill Air Fuel ratio on fineness in the Pulverizer unit 6 of the Suralaya Steam Power Plant..... 87

Numerical Study of Dual Fuel Engine using Proportional Natural Gas Split Injection..... 88

Investigation of Dual Fuel Engine Performance Based on Proportional CNG Substitution89

Effect of B20 Heating on the Macroscopic Fuel Spray Characteristic..... 90

An Experimental Investigation of Natural Gas Injection Timing on Dual-Fuel Engine..... 91

Numerical Study of a Savonius Wind Turbine with Standard Blades and Bach Blades Variations 92

Performances of Three Solar Distillators with Different Absorbers 93

Effect of Natural Gas Injection Pulse Width on Dual Fuel Engine Performance 94

Investigation the Effect of Superficial Velocity to the Heat Transfer in Bubbling Regime of Fluidization Using CFD Simulation..... 95

Numerical Investigation of Flow Through Square Duct With Installed Tripping Rod on square Elbow 96

Combustion And Emissions Characteristics On Stationary Diesel Engine With 30% Water in Diesel Emulsion Fuel 105

Site Investigation on Water Cooled Chiller Plant for Energy Conservation and Environmental Impact Reduction of a Large Shopping Mall 106

Analysis of Particulate Dispersion from Coal Use in Suralaya Coal-fired Power Plant.. 107

Experimental Study The Effect of Excess Air in to Unburn Carbon and Boiler Efficiency Using Coal with Heating Value 4200 kcal/kg at a 500 MW Capacity Power Plant 108

The Effects of Pilot Injection Timing in Dual-Fuel Diesel Engine using Biodiesel-CNG on The Combustion Characteristics and Exhaust Emissions 109

Numerical Study Effect of Burner Tilt Angle on the Boiler Rear Pass Temperature on PLTU Banten 1 Suralaya under LRC and MRC Coal Conditions 110

Numerical Simulation Of Coal Particle Size (Fineness) Effect To Combustion Characteristics Of Sub-Critical Pulverized Coal Boiler 600 MW Capacity 111

The Effect of Compression Ratio Variations to Engine Performance and Emissions Characteristics on Diesel Engine Fuelled With Ethanol-Intermediate Sulphur Content Diesel Fuel (Dexalite) Blend 112

Modeling and Simulation of Engine Speed on Idle Speed Conditions System by using MIMO on Spark Ignition Engine..... 113

Effect of 35% Water in Diesel Emulsion Fuel And AFR Enriched Combustion On The Combustion And Emissions Characteristics 114

Development and Experimental Evaluation of Small Concentrated Solar Oven..... 115

Passive Flow Control on Square Duct and 90° Elbow with Circular Turbulator at Certain Gaps 116

Numerical Study on the Performance and Flow Field of Varied Conical Basin for Efficient Gravitational Water Vortex Power Plant..... 117

Design Evaluation of an Automotive Radiator for Student Formula SAE Vehicle "Bimasakti": Thermal Calculations..... 118

Analysis of an Optimum Method for Power Generation Using Flare Gas from Oil Refinery Plants 119

Numerical Study of Optimization Performance Induced Draft Fan Through Openings Setting the Inlet Guide Vane 120

Numerical Analysis of Conjugate Porous Media for Increasing Heat Transfer Rate in Fixed Bed Spheres 121

Flow Structure Investigation Heat Transfer Enhancement on Inner Tubular Pipe with Winglet Vortex Generator 122

Material

Influence of Thermal Cycling of Cold Rolled Stainless Steel 316L onto Hardness and Microstructures..... 124

3D Reconstruction of Rolling Contact Fatigue Cracks in Rails with Tight Serial Cutting125

Friction and Wear Performance of Phosphonium-based Ionic Liquid Additives in Glycol Media..... 126

The Effect of Acidity and Rotation Speed in Titanium Dioxide Synthesize Process 127

Fabrication Membrane of Titanium Dioxide (TiO2) Blended Polyethersulfone (PES) and Polyvinilidene Fluoride (PVDF); Characterization, Mechanical Properties and Water Treatment..... 128

An Experimental Investigation of Geopolymer Composite Reinforced by Short Carbon Fiber 129

Low Cycle Fatigue Properties of Aluminizing Coating on Cold-Drawn AISI 1018 Steel 130

The Performance of Carbide Waste as an Adsorbent to Reduce Spark Ignition Engine Emission 131

Application of Seeds from Psidium Guajava as Organic Inhibitor 132

Effect of Ground Glass Particles on The Water Absorption and Tensile Properties of Epoxy 133

Improving of Electric Voltage Response Based on Improving of Electrical Properties for Multiferroic Material of BiFeO3-BaTiO3 System 134

Root Caused Failure Analysis of Tube Pendant Superheater in 660 MW Coal Power Plant 135

Corrosion Behavior of a Predeformed FeNi Lateritic Steel with Bainite Structure 136

Effects of Manganese Addition on the Microstructures and Mechanical Properties of Cu-29Zn-0.5Al Alloys 137

Aging and Degradation of Electrode Cu Spot Welding On The Thin Plate Low Carbon Steel 138

Analysis on Superheater Tubes Degradation at a Tangentially Fired Pulverized Coal Power Plant 139

Correlation of Holding Time and Bottom Ash Particle Size to Mechanical Properties of Polypropylene Composite 140

Evaluation of Inhibitive Action from Papaya Leaf on Surface API 5L Grade B in Acid Solution 141

Natural Fiber Reinforced Composites as Bulletproof Panel Materials 142

Effect of Vehicle Speed to the Fatigue Life of a Coil Spring Based on Strain-Life Approach 143

Tensile, flexural and water absorption properties of bamboo fiber/unsaturated polyester composites: Effect of calcium carbonate content 144

Effects of Oil Palm Empty Fruit Bunch and Magnesium Oxide Volume Fraction on Mechanical Characteristics of Railway Brake Block Composite Material 145

Analysis of Condensor Tube Thinning Distribution and Their Failure Modes Based on Eddy Current Data 146

Carbon and Nitrogen Composition for Non-Precious Metal Catalyst to Physical Characterization and Electrochemical Properties 147

Natural Fiber Reinforced Composites as Bulletproof Panel Materials 148

Effect of Vehicle Speed to the Fatigue Life of a Coil Spring Based on Strain-Life Approach 149

Tensile, flexural and water absorption properties of bamboo fiber/unsaturated polyester composites: Effect of calcium carbonate content 150

Effects of Oil Palm Empty Fruit Bunch and Magnesium Oxide Volume Fraction on Mechanical Characteristics of Railway Brake Block Composite Material 151

Analysis of Condensor Tube Thinning Distribution and Their Failure Modes Based on Eddy Current Data 152

Carbon and Nitrogen Composition for Non-Precious Metal Catalyst to Physical Characterization and Electrochemical Properties 153

Analysis The Effect Of Charcoal Mass Variation To Ni Content, Sinter Strength and Yield On Sintering Process Of Limonitic Laterite Nickel Ore 155

Direct Reduction of Limonitic Laterite Nickel Ore with Variation Type of Reductor to Fe, Ni Content and Recovery by using Coal-Dolomit Bed Method 156

The Effect of Citric Acid Concentration on Corrosion Behavior of Austenitic Stainless Steel 316 L 157

Deformation Analysis of Internal Fixation Plate on Femur Bone Fracture Considering Material Variation 158

Effect of Stirring on the Quality of ADC 12 Cast Aluminium Alloy 159

Impact Toughness Characteristics of SM570-TMC Steel Joint Using Welding Wire Containing 0.4% Nickel at Different Level of Heat Input 160

Non-monotonous Effect of The Adhesive Thickness on The Stiffness of Adhesive Butt Joint at High Strain Rate Loading 161

Failure Investigation of A Steering Bearing in Matic Motorcycle 125 cc 162

Numerical convergence in wear volume prediction of UHMWPE acetabular cup paired with cp Ti femoral head hip implants 163

Dissimilar Joining Metal of Aluminum 6061 and Galvanis Pipe Using Friction Welding Method 164

Extraction and Characterization of Nanocrystalline Cellulose (NCC) from Ramie Fiber by Hydrochloric Acid Hydrolysis 165

Plug and Play Manhole Kit Holder for Storage Tank: A Comprehensive Design Analysis 166

Manufacture

Optimization of Welding Parameters Effect of Metal Inert Gas on a Steels Joint 168

Multi Objective Optimization in End-Milling of Carbon Fiber Reinforced Polymer Using Backpropagation Neural Network-Ant Colony Optimization 169

Optimizing the Machining Conditions on Friction Stir Welding of Aluminum Alloy through Design Experiments 170

Effect of a Dissimilar Thin Plate Joint of Metal Inert Gas 171

Effect of grain size on silica blasting processes on the roughness of medical grade SS316L 172

Development of Tools Utilization Monitoring System on Labor-Intensive Manufacturing Industry 173

Analysis of Chips Formation in Subtractive Manufacturing for Working Safety 174

Effect of Feeding and Depth of Cut on Surface Roughness in Truing and Dressing Process Using Cylindrical Grinding Machine 175

Multi Objective Optimization in End-Milling of Carbon Fiber Reinforced Polymer Using Backpropagation Neural Network-Genetic Algorithm 176

Effects of Processing Parameters on The Tensile Strength of Injection Moulding Unidirectional Glass Fiber Reinforced Polypropylene Composite 177

The Phase Transformation of CP-Titanium Grade 2 and AISI 316 L in Cardiovascular Stent Manufacturing by Die Sinking EDM 178

Effect of Punch Angle and Punch Radius on Bending Angle through V-Bending Process of Sheet Metal 179

Prediction of Cutting Force in End Milling of Glass Fiber Reinforced Polymer (GFRP) Composites Using Adaptive Neuro Fuzzy Inference System (ANFIS) 180

Process Simulation Based on 3D Printed Vero-Clear to Produce Injection Mold Inserts 181

Life Cycle Cost and Replacement Analysis for Power Plant Generator 182

Design Analysis in the Application of Solar Energy for Crossing River HDPE Boat 183

Multi-Response Optimization of Vibration and Surface Roughness on the Surface Grinding Process Parameter Using OCR12VM Material With Taguchi-Grey Method 184

Influence of Test Piece Geometry to the Plastic Deformation of Balloon Expandable Stent 185

Assembly Line Design in Final Assembly Excavator at PT.XYZ Using Genetic Algorithm 186

Surface Roughness Characterization of Medical Implant Material SS316L Stainless Steel After Cut With Water Jet Cutting Process 187

Surface Roughness Evolution and Dimensional Changes of Magnesium Alloy Plate during Electropolishing 188

The Combination Effect of Machine Dynamic Behavior, Laser Power and Scan Speed on the Accuracy of Single Layer Bead Corner Formation in the Selective Laser Melting 189

The Combination Effect of Machine Dynamic Behavior, Laser Power and Scan Speed on the Accuracy of Single Layer Bead Corner Formation in the Selective Laser Melting 190

Replacement Scheduling of Brine Heater Desalination Plant Using Binary Integer Programming Method 191

Numerical Structure Analysis of Air Purifier Bike with Frame Designs and Materials Variation 192

The Effect of Processing Parameter on Composite's Impact Strength of Continuous Unidirectional Polypropylene-Glass Fiber Composite 193

Macro-micro Analyses on 2-layer Semiautomatic MIG Welding of AA5052 Material Using ER5356 Electrode 194

The Effect of Suction Pressure of Vacuum Clamping on the Result of Aluminum Plate Cutting Process using Mini PC-Based CNC Milling 195

Waste Analysis to Improve Container Port Performance Using Lean Six Sigma Method 196

Influence of Test Piece Geometry to the Plastic Deformation of Balloon Expandable Stent 197

Control

Design of Sliding Mode Control for Surge, Heave and Pitch Motion Control of UNUSAITS AUV

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Abstract. AUV has 6 degrees of freedom derived from a propulsion system that regulates the angular speed of AUV and the fin system that adjusts the angle of the fin and rudder positions. In this paper, an AUV motion control system design for diving was developed, that is, the control system of surge, heave and pitch motions by applying Sliding Mode Control (SMC) method. The AUV specification used in this study was an UNUSAITS AUV with a length of 1.5 meters, a weight of 16 kilograms using controller of arduino mega 2.0. The main contribution of this paper is Control system for nonlinear models of 3-DOF UNUSAITS AUV. The simulation results showed that the SMC method could be used as a 3-DOF motion control system with an error of 5% for surge motion and 0.01% for heave motion and 2% for pitch motion.

Keywords: *AUV, control system, surge, heave, pitch, sliding mode control*

Performance Analysis and Comparation of BLDC Controller Trapezoidal and FOC

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Abstract. The main component of an electric vehicle is the brushless DC Motor Controller. To support the acceleration development of national electric vehicles required controller technology for brushless DC Motor. The development of brushless DC Controller technology is required to get better performance and efficiency. FOC are used for Controlling brushless DC Motor because it can operate smoothly over the wide speed range and capable for quick acceleration and deceleration. FOC are directly control of torque and speed based on the electromagnetic state of the brushless DC Motor. Brushless DC motors used for electric vehicle applications have transient conditions. Need method to improve FOC in transient condition. This paper has the following contribution: improvement FOC Controller to address transient condition in start-up brushless DC Motor using look-up table. This proposed method will certainly change the Controller's design paradigm, so that the Controller can provide power in accordance with the needs of electric vehicle load and every one can tuning this Controller. Controllers using this method will minimize the current in the phase at Start-up. The performance will be compared with existing method using brushless DC Motor 5 KW

Keywords: *FOC, look-up table, transient condition.*

Towards Intelligent and Reconfigurable Brushless Direct Current (BLDC) Motor Controller

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Abstract. The main component of an electric vehicle is BLDC Motor Controller. At present, the motor controller is difficult to matching with universal brand BLDC motor. One of the reasons is the motor parameter not accordance with the physical condition of the motor. This paper presents an intelligent and reconfigurable BLDC motor controller. Switching commutation on phase will auto reconfigure. It was adapted by configuration of hall sensor and phase. Duty cycle and frequency of Pulse Width Modulation (PWM) adapt with value of BLDC motor parameter. Value of BLDC motor parameter obtained by auto detection parameter feature. BLDC motor parameter consist of internal resistance, inductance, coefficient of BEMF (ke), coefficient of Torque (kT), coefficient of Friction (B), Moment of Inertia (J) and time constants (τm). Feedback in BLDC Motor controller are hall effect sensor, phase current, BEMF, and input voltage. Hall effect sensor are represented speed rotor and position rotor. All value of this feedback use to determine motor parameters. BLDC motor controller using this algorithm can match with various brands of BLDC Motor in the world.

Keywords: *reconfigurable, commutation, auto detection*

Short Circuit Study On Ship Dynamic Positioning System Based On Laboratory Scale Experiment

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Abstract. Dynamic Positioning is a control system that can maintain ship position to the object on horizontal axis. With the degree of freedom of the ship, the Dynamic Positioning system maintains the position of the ship from sway and surge movements . With the degree of freedom of the ship, the Dynamic Positioning system maintains the position of the ship from sway and surge movements . The term short circuit fault is used to explain that the conductor is briefly connected. There are two values of short circuit current failure that must be evaluated. The first is the maximum short circuit current. The maximum value of the short circuit current will be related to the short circuit current in the terminal around the protection device. Second, the short circuit current is minimal. The value of this current is important to use when selecting the current-time curve for circuit breakers and fuses.

Keywords: *dynamic positioning, short circuit, AHTS vessel*

Earthquake Waveform Data Conversion using Seisan and Seizmo for Magnitude Study Comparison

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Abstract. In the past few years, Earthquakes have struck Indonesia several times, which caused many people to lost their live. Every day, The Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG) is responsible to monitor the seismic activity through several stations located around the country and record them as waveform including any Earthquake that occurs and determine their magnitude respectively. The aim of this study is to collect those waveform raw data from BMKG and able to utilize several tools to convert and process the data for further research purposes. One of the purposes is to compare the waveform data with the determined magnitude and to find the relationship between them. This paper served as discussion in seismology and better understanding of Earthquake..

Keywords: *earthquake, waveform, seisan, seizmo, earthquake magnitude*

Position Estimation of Touristant ASV Using Ensemble Kalman Filter

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Abstract. An Autonomous Surface Vehicle (ASV) is a vehicle in the form of a ship on the surface of the water that can move without a crew on it or operate automatically. This study used the Touristant ASV with a length of 4 meters, a diameter of 1.5 meters, and a height of 1.3 meters. The contribution of this paper is the estimation of ASV position and ASV motion influenced by wind speed and wave height. The estimation method used is the Ensemble Kalman Filter (EnKF) method, then EnkF is applied to the nonlinear ASV model to get a small position error. The implementation of the EnKF method covered 3 simulations, that is, by generating 100, 200 and 300 ensembles. The position error generated from the simulation showed that the simulation with the lower position error has an accuracy more than 95%. The position error of x is 0.009 meters, the position error of y is 0.008 meters, and the position error of XY plane is 0.01 meters

Keywords: *autonomous surface vehicle (ASV), ensemble kalman filter, 3-DOF, touristant ASV*

Design

Power Prediction of a 4-CRU Parallel Mechanism Based on Extra Gradient Boosting Regressor

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Abstract. Power analysis of a robot is the last step of the dynamic modelling after calculating its kinematics. The power calculation takes a long time due to the complexity of the process. This paper deals with the power prediction of a 4-CRU parallel mechanism by using Extra Gradient Boosting Regressor (XGBR). XGBR is one of the algorithms in machine learning that can take good learners and leave weak learners from the models built. Then, XGBR is optimized using Random Search to overcome the hyper parameter tuning with the best prediction accuracy. The XGBR tuned hyper parameter was performed a satisfactory prediction model. The prediction results can perfectly show the robot behavior since it is based on the smallest error of model prediction. The error value based on Mean Absolute Percentage Error (MAPE) is 0.05099% and based on Mean Square error (MSE) is 0.0001 which took 11 minutes. The value of accuracy and efficiency is very reasonable to say that the power prediction model of a 4-CRU parallel mechanism has successfully performed.

Keywords: *power prediction, parallel mechanism, extra gradient boosting regressor*

Numerical Homogenization of Viscoelastic Composites with Elliptical Piezoelectric Fiber

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Abstract. In this paper, effects of effective visco – electro – elastic moduli of elliptiocal piezoelectic materials with different aspect ratios are studied. The numerical model is developed by COSMOL Finite Elelment (FE) package and compared against existing analytical results from the literature. The elliptical PZT fibers are analyzed by varying the aspect ratio and volume fraction, and the result shows that the material properties are strongly dependent on the frequency dependence of the viscoelastic matrix. The effective elastic coefficient C_{33}, the piezoelectric constant e33 and the dielectric constant e_{33} are not affected by different aspect ratio when is volume fraction fiber is small (V_f =0.1). However, the aspect ratio starts to affect the properties gradually when volume fraction of PZT fiber is increased. Comparison of numerical results with analytical results available in literature shows good prediction.

Keywords:

Free Vibration Characteristics of Jute Fibre Reinforced Composite for Determination the Material Properties: Numerical and Experimental Studies

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Abstract. Jute fiber reinforced polymer composite (JFRPC) is a one of natural fibers composite that have recently become attractive used in automobile, aerospace, buildings and other industrial applications due to their light weight, less cost, bio - degradability and easy to fabricate. It becomes necessary to know the material properties and dynamic characteristic of natural fiber reinforced composites to use it effectively for engineering applications. This paper presents numerical and experimental studies of dynamic characteristic of jute fiber reinforced polymer composite for estimation Young's and shear modulus. Finite element method (FEM) and impulse excitation technique (IET) were used to determine natural frequency value of a plate JFRPC. The result shows that the natural frequency is significant and applicable for mechanical properties identification especially Young's modulus (E), shear modulus (G) and Poisson ratio (v) of a jute fiber reinforced polymer plate. This method is expected to prediction mechanical properties of other materials and prospective as non-destructive evaluation approaches.

Keywords: *material properties, impulse excitation technique, vibration characteristic, jute fiber reinforced polymer composite*

Biomechanical Analysis of Correction Force and Cobb Angle in Scoliotic Spine Fixation

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Abstract. Scoliosis is a medical condition in which a person's spine has a sideways curve. Treatment to reduce the scoliosis depends on the degree of curve, location, and causes. Surgery is commonly recommended by orthopedists for curves with a high progression by installing implants that consisted of pedicle screws, rods, and connectors. However, many cases of failure both in the implant structure and the interface of bone and pedicle screw connections were found caused by corrective force. The bigger Cobb angle directly means the increase of correction force, which acts on bone-implant interface during scoliosis surgery. In the present study, estimated corrective forces are investigated using Finite Element Analysis (FEA). The research is carried out by modeling a normal and a scoliotic spine with specific Cobb angle, by this case which is 500. The forces are applied in various number of pedicles screws that implanted in thoracic spine, i.e. single pairs, three pairs and five pairs of screws. It is found that the force will increase significantly by reducing the number of screws. The biggest correction force for 5 screws is 54.5 N in the apical section, while it is 218 N for single screws. It is needed to find the optimal number of using pedicle screws based of the working force and stress and implant cost

Keywords: *biomechanics, spine, scoliotic, the cobb angle, pedicle screw*

Effect of Contact Surface Temperature on Wear of Nickel-Chromium Layer

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Abstract. In sliding contact of two components, the contact temperature will be generated due to the friction force and this may alter the wear resistance of the material. However, the elevated contact temperature may develop oxide layers at the surface and thus may protect the material to fail by wear. In this work, the contact surface of the material of the medium carbon steel was coated with Nickel-Chromium in the process of flame powder spray coating. To determine the effect of the elevated temperature at the contact surface on the wear of the Nickel-Chromium layers, the wear test was conducted using linear reciprocating ball-on-plat with the varying surface temperature in the range of 30ºC, 50 ºC, 100 ºC, 150 ºC, 200 ºC, 250 ºC and 300ºC. The results show that the wear rate decrease from about 0.0347x10-3 to $0.0083x10^{-3}$ gr/m for the temperature of 30ºC and 50ºC, respectively and with increasing the surface temperature up to 300ºC, the wear rate slightly fluctuated between 0.0023x10-3 and $0.0053x10^{-3}$ gr/m. This wear rate mechanism may be affected by existing the oxide layer at the contact surface.

Keywords: *nickel – chromium, coating, surface temperature, wear*

Geometric Modeling of Fore Body Surface Remotely Operated Vehicle (ROV) Observation Class

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Abstract. Sunda Strait of Indonesia needs one technology to find information on its bottom, and correct technology is ROV. The available ROV has limitation, which is design structure and hydrodynamic respond. Preliminary research about design concept has also been conducted to develop the existing ROV. This study aims to develop existing ROV and also to continue preliminary research about design concept of ROV, and to obtain the best geometric modeling of fore body surface of ROV. The method used is Granville, which is determining parametric profile of ROV body which has streamlined body geometric. The result of this study is modeling K_1 (curvature on x_m) and r_n (curvature radius of fore edge) so that the best curve geometric modeling fore body of remotely operated vehicle (ROV) of observation class can be obtained.

Keywords: *Sunda Strait, geometry modelling, ROV*

Numerical Study Of Heat Transfer And Stress-Strain On 2 Joints And 3 Joints Soot Blower Lance Tube At Suralaya Power Plant

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Abstract. Reliability on thickness and grade material side, then overhung mechanical strength very important for cleanliness of tube bank boiler 600 MW. Proper Operation and maintenance very effected for soot blower system reliability. Objective of the research are knowing heat transfer characteristics of lance tube, thermal stress due to high temperature flue gas, and lance tube overhung mechanical stress. During soot blowing there are area possibility of permanent deflection happened that showing plastic deformation and should avoided.

This research start with 3D geometry modelling, meshing and determine boundary condition with computational Fluid Dynamic software. This software use k-epsilon enhanced wall treatment, energy equation, SIMPLEC. Heat flux variation of lance tube soot blower then temperature distribution is obtained. Then conduct finite element modeling where load model are thermal stress, overhung mechanical stress, and stress due to steam jet.

Simulation results are temperature distribution is kept on between 560^{o}C until 650^{o}C. it is expected that 3 joints is more reliable than 2 joints lance tube soot blower.

Keywords: *fluid dynamic, finite element modelling, mechanical stress lance tube soot blower*

Urban Soundscape Prediction Based On Acoustic Ecology and MFCC Parameters

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Abstract. Many studies has been conducted to predict the urban soundscape based on acoustic parameters. In this study, the prediction of urban soundscape composition based on acoustic ecology and MFCC parameters is conducted using binary logistic regression. Six parameters of acoustic ecology (ACI, ADI, AEI, BI, H and NDSI) and 12 MFCC parameters were used to predict the perception of relaxation, dynamic and communication. A dataset of 600 urban sonic environment compositions with the perception ratings (based on the perception of relaxation, dynamic, and communication) were used in this study. The acoustic ecology and MFCC parameters were calculated from the sonic environment composition audio files. The analysis using binary logistic regression shows that parameters of MFCC gives significant level at 90 % for the perception of relaxation, dynamic and communication. The model prediction based on the significant parameter gives the Correct Classification Rate: relaxation (CCR = 88.3 %), dynamic (CCR = 77.6 %), and communication (CCR = 59.3 %). The results indicate that the parameter of MFCC could be a better predictor of sound perception rather than the acoustic ecology.

Keywords: *soundscape, accoustic ecology, mel – frequency cepstral coefficients, binary logistic regression*

Evaluation of Derailment Risk by Simplified Analytic Procedure and Computer Simulation

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Abstract. One of the tasks has to be done by engineer in the design process of a new rail vehicle is the evaluation of derailment risk in order to ensure the safety of the vehicle against the derailment accident. Performing such task by time-series simulation using computer software is time consumed, high cost as well as difficult especially in the early design stage where only limited information available. It is practical in the rail car manufacture industry that when firstly define the vehicle configuration a procedure using simplified analytic equations is used to evaluate the sensitivity of the vehicle against derailment prior to the computer simulation in the later stage. This paper examines the procedure of the calculation of derailment risk parameters using simplified analytic equations and compare it with the result of computer simulation of full multibody dynamics model of a railway vehicle.

Keywords: *rail vehicle, derailment risk, dynamics simulation*

Design and Analysis for Vibration Assisted Micro Milling

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Abstract. Vibration Assisted Machining is an example of sustainable manufacturing concept application and as an alternative machining process, to improve machine performance and machined surface quality. Machine construction and system respond toward the applied active vibration, actuator selection with a function to generate vibration, the direction and placement of vibration on to the machine, workpiece properties, and product complexity of the required product, are the main aspects to design Vibration Assisted Machining for machining process especially in microscale. VAM design had been introduced and investigated by many researchers for many types of machine and manufacturing process, thru the structural static and dynamic load on to machine structure due to the vibration additional at its resonant frequency toward the machined surface quality, by conducted simulation or experimental or comparison of both. Nevertheless, the research about VAM design development for the miniaturized machine for milling was still limited. Thus this paper would like to introduce VAM mechanism in which the workpiece would be positioned and customized for miniaturized milling machine, by implementing product development evaluation and finite element method to obtain the stress and displacement plot. Piezoelectric actuator and flexure combination was chosen as the most compatible design in comparison to the application of mechanical and vibration motor system. Finite element simulation showed VAM able to uphold the targeted machining forces and to vibrate workpiece with displacement within several micrometers.

Keywords: *vibration assisted machining, micro milling, piezo actuator, product development process, finite element*

Dynamic Trajectory Generation of Suspended Cable Driven Parallel Robot

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Abstract. This paper focuses on the trajectory planning of a fixed frame suspended Cable-Driven Parallel Robots (CDPR). The robot consists of four cables. The cables are attached to a cube moving platform at one end, and winches at the other end. The aim is to deliver the trajectory while maintaining dynamic equilibrium. The equilibrium is bounded by a set of constraints that must be satisfied. These constraints are positive tensions and error limits. Two trajectories will be studied, namely vertical oscillation and circular horizontal. It is shown that both trajectories can be executed.

Keywords: *CDPR, trajectory planning, optimization*

Modification, Manufacturing, and Testing of Three Axes Load cell

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Abstract. Three axes load cell is an important component in the force platform. Force platform could be used to measure Ground Reaction Force (GRF) and Center of Pressure (CoP) of movement in the study of human movement. Due to the importance of load cell in the force platform, the three-axes load cell was modified from load cell YGX952 series so it is more affordable. Manufacturing and testing of the modified load cell was also conducted in the present work. The modification of load cell YGX952 series begins with designing process, including determining the dimension and tolerance of the load cell. Then, the statics analysis was carried out to obtain the maximum stress suffered by the load cell. The iteration was conducted if the maximum stress was larger than the yield strength of the material. The next step is the manufacturing and testing the load cell. The test results show that load cell is able to measure force in each axis with small error. Those making process of three-axes load cell is expected to be a reference in the production of affordable load cells as a component of the force plates.

Keywords: *load cell, three axes, design process, reverse engineering*

Optimization in Airless Tires Design Using Back-Propagation Neural Network (BPNN) and Genetic Algorithm (GA) Approaches

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Abstract. Tires are one part of a vehicle which the functions not only for increasing comfort but also increasing safety during driving. Commonly, the types of tires on the market are categorized into three types, namely: radial tires, solid tires, and airless tires. The first type is radial tires which are widely used for mass transportation (i.e., bus, truck, van, etc.) regarding their ability in providing excellent comfort during operating. However, this tire has several disadvantages such as a complicated manufacturing process, level of comfort and security are influenced by the air pressure inside of the tire, and can be damaged due to outside influences stuff such as nails, screw, etc. The second type is solid tires which are used on as forklifts, dump truck, etc. to lift heavy loads at low speed. On the contrary compare with the first type, although it is relatively safe against the negative effects of the sharp objects, the solid tire type has a low level of comfort since the shock absorption ability for this tire is very poor. Airless tires are designed and produced to overcome problems in the radial tires and solid tires. This tire provides a safe and comfortable driving experience in a vehicle during operation. Moreover, using airless tire a vehicle still works when sharp objects hit the tire.

This research will be focused on designing airless tires with spoke in the form of rhombic networks using three parameters, namely spoke thickness, rhombic angle, and percentage of hardener on polyurethane rubber material. Each parameter uses three different levels so the total design number is 27 designs. The thickness parameter of spoke levels was varied from 4 mm, 7 mm and 10 mm, where the rhombic angles parameter was varied from 102o, 120o, and 132o. The last parameter (i.e., percentage of hardener on polyurethane rubber material) was varied from 10%, 20%, and 30%. The value of deflection, stiffness, and total stress every model are then calculated using finite element software.

Furthermore, artificial intelligence using backpropagation neural network (BPNN) was developed and utilized as a forecasting tool to predict the relationship between input (i.e., spoke thickness, rhombic angle, and percentage of hardener on polyurethane rubber material) and output (deflection, stiffness and total stress) of the airless tire models. Moreover, an optimization method using genetic algorithm (GA) is then employed to find the best design of the airless tire and this design will be selected to be produced as a prototype product.

Keywords: *airless tires, backpropagation of neural network, genetic algorithm*

Modularization of Ship Engine Room Using Design Structure Matrix (DSM) Based on The Genetic Algorithm

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Abstract. Recently, the shipbuilding industry has been able to develop new production methods. This new method promote design automation in order to produce ships more efficiently. The various production concepts, like block division, modularization and building ships with a standard design are possible solutions for improve production. Engine room design, including the piping system, is a complex process; therefore, modularization of its design is an effective strategy to minimize the complexity of the system. In addition, modularization plays an important role. This process requires a considerable number of man hours. This paper presents a new approach for engine room design based on the modularization concept. The characteristics of the proposed method are as follows: • Attention was paid to all piping systems of ship engine room. The cost and weight of the piping system were considered. • To define an effective module, a design structure matrix was adopted. • In the modularization using DSM, the Genetic algorithm is used to obtain modules by considering some constraints like number of pipe connections and pipe cost. This study discusses the details of the above-mentioned methods. In addition, simulation test of design optimization of a several piping systems were carried out to illustrate the design optimization procedure in detail and to verify the effectiveness of the proposed methodology.

Keywords: *modularization, piping system, design structure matrix (DSM), genetic algorithm*

Analysis Properties of Rock Mechanics in JIIPE area, Gresik, East Java, Indonesia for Tunnel Construction using Deformation Methods in MATLAB Application

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Abstract. JIIPE Gresik's Industrial Area, East Java, Indonesia is located in Randublatung depression zone, which is rich of sedimentary rock. In this study, we use two samples sedimentary rock (samples K2 and K5) that have been coring before. We have did calculate dimensions (diameter, height, and mass); axial deformations; transversal deformation of samples K2 and K5 used to determine stress's value when the rock samples have been fractured and calculated modulus elasticity, so that we can analysis strength of the rock samples can use for raw material of tunnel construction. In this study, we use "versa tester" and "dial gauge" to give compression stress for rock samples K2 and K5 and we got the stress value: 0.937131 MPa rock samples K2 had been fractured, and when the stress value: 0.867409 rock samples K5 had been fractured. Also in this study we got value modulus elasticity of rock samples K2 is 10.13370616 MPa and value modulus elasticity of rock samples K5 is 24.30410248 MPa. After we compared with theoritical value from modulus elasticity of rock and soil, we can know the rock samples K2 is soft clay and rock samples K5 is medium clay. The theoritical value from modulus elasticity of soft clay is 4.1-20.4 MPa and medium clay is 20.7-41.4 MPa. In this paper, next we got curve about stress, strain, and modulus elasticity use MATLAB Apllication. As we can know, clay can't use for raw material of tunnel construction because of the swelling clay process, properties of its elasticity that is easy to had been fractured and their value of modulus elasticity stated if rock samples K2 and K5 relatives had low strength. However, clay can use for additional material for tunnel construction (cement).

Keywords: *modulus elasticity, strain stress, swelling clay, unconfined compressive strength*

Power and Tractive Force Analysis of Series-Parallel Hybrid Vehicle Based on Road Test (Case Study: Toyota Prius Hybrid)

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Abstract. The automotive industry is predicted to grow in the next few years. The stretch of road infrastructure development from west to east Indonesia is expected to become one of the catalysts for the growth of the automotive industry in 2019 with the target of achieving car sales. However, the growth of the automotive industry in Indonesia is not accompanied by the development of automotive technology in hybrid vehicles. For this reason, with a comprehensive analysis of traction performance in hybrid vehicles, it is hoped that it can become a basis for adjusting between the needs and performance of hybrid cars. The vehicle that became the object of research was the 2017 Toyota Prius Hybrid. This research was conducted using vehicle road test data. Data obtained from vehicle road test results include vehicle speed (vk), vehicle power (P_k), electric power (Pe), engine power (Pen), engine speed (en) and regenerative energy. The results will be obtained in this study is in the form of a relationship between electric power, engine power and vehicle power from the Toyota Prius Hybrid 2017. Furthermore, the operating mode will be obtained from the vehicle. Then road load horsepower is obtained based on the driving cycle that will be used to graph the required tractive force and generated in each operating mode.

Keywords: *driving cycle, power, tractive force*

Power and Tractive Force Analysis of Series-Parallel Plug-in Hybrid Vehicle Based on Road Test (Case Study: Toyota Prius Plug-in Hybrid)

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Abstract. The technological development of the car industry in recent years has been very rapid and has been followed by excessive use of fossil fuels which has resulted in the emergence of various global problems. Electric vehicle (EV) is one of the solutions that is currently active to be developed. In EV, especially PHEV, the battery component is a very critical component of the vehicle and battery optimization based on driving profile which has an impact on the difference in selling prices of vehicles can provide more attractiveness to customers so that further studies are needed regarding the use of hybrid vehicles on the Indonesian track. Based on this, the author analyzes the power and traction characteristics of the 2017 Toyota Prius PHV based on the driver's driving cycle, both in the city and on the highway in the city of Surabaya. In this study, the author uses data from the results of vehicle road testing. This work discusses the relationship between vehicle power, engine power, electric power, accessories power, regenerative energy, and SOC ratio from the Toyota Prius PHV 2017. Furthermore, the operating mode will be obtained from the vehicle based on that relationship then road load horsepower is obtained based on the driving cycle that will be used to graph the required and generated tractive force in each operating mode.

Keywords: *plug-in hybrid, power, tractive*

The Influence of Un-lean CNG Injection to the Material Strength of the Single Cylinder Dual Fuel Diesel Engine

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Abstract. Strengthening marine pollution (MARPOL) Regulations 13 which bring technical code of TIER III affect many strategic ways to deal with. The code of TIER III multiply more than three times than TIER II as predecessor. It is not so easy to comply with. There are only three methods to fulfill the new standard, first, is using gas as fuel, second, de-rating of the power output, and third is install SCR (Selective Catalytic Converter) unit. This research work is deal with the first method, use CNG (Compressed Natural Gas) as fuel for diesel engine in the form technique called as dual fuel system. Established system inject the gas in lean condition and still facing the unexpected result called as knocking. The data of energy content shows that CNG lower than HSD (High Speed Diesel). Then the purpose of this research is investigates the possibility to improve the quantity of gas in cylinder combustion process. The gas will be increased to the un-lean stoichiometric condition to extent more power output. Engine will be modified by making bigger area in the piston crown bowl. The bigger power output may risk to the strength of material. Two model of new piston will be proposed here. This paper focus on the discussion of the influence of the increment CNG injection to the strength that accepted by the new design piston. Hopefully, this small scale modeling work of a single cylinder engine can make big contribution in the development of bigger size marine diesel engine in occupy gas fuel safely. Gas as fuel offer many benefits technically and economically.

Keywords: *CNG, dual fuel, diesel engine, piston engine, un-lean fuel injection*

Operator Splitting Method for Solving Anisotropic Problem

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Abstract. The electroencephalography (EEG) is a non-invasive technique to study electrical brain activity (while brain is performing a cognitive task). The electrical brain activity is a complex process of electrical propagation because the brain structure is an incredibly complex structure. This complex structure leads to different conductivity property in term of its magnitude and orientation, called anisotropic conductivity. Using Maxwell's equations, the electrical brain activity has been studied intensively. For simplification, the quasistatic Maxwell's equations are used to model the electrical brain activity and it leads to deal with a Poisson's equation.

For a realistic model, the conductivity in Poisson's equation should be considered as anisotropic. In this research, a feasibility study of using a new method, called Operator Splitting Method (OSM), to solve anisotropic 2-Dimensional (2D) Poisson's equation is performed. A freeware of finite element method (FEM), FreeFEM++, is employed to build matrices used in the OSM algorithm. The OSM algorithm which is written in Matlab is then tested to solve an anisotropic Poisson's equation with dipolar source. Afterwards, the OSM solutions are validated by using exact solution and direct numerical solution. By using L2-Error Norm, the convergence rate of the OSM algorithm is then analyzed.

Some numerical experiments have been performed to test the performance of the OSM algorithm. The OSM solution of anisotropic 2D Poisson's equation with dipolar source coincide with the exact and direct numerical solution of the problem. The pattern of the OSM solutions are similar to the pattern of direct numerical solutions of the problem. The results arise a hope or motivation to attempt implementing the OSM algorithm for more complex problem such as a realistic human head model.

Keywords: *Maxwell equation, Anisotropic Conductivity, Operator Splitting Method, FEM, Poisson equation*

Topology Optimization on Geometry of 3D Printed "Impulse RC Alien 4 Inch" Racing Quadcopter Frame with Polylactic Acid Material

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Abstract. The racing quadcopter is one of UAV type which is designed for high speed. Frame of racing quadcopter is normally manufactured from carbon fiber material because of its lightness and rigidity, however, it is very expensive. That's why alternative material, like polylactic acid (PLA) is significantly considered. But polylactic acid frame needs some optimization treatments to achieve same mass and rigidity as the carbon fiber one. One of the structural optimization methods that can be used is topology optimization. Although this method will generate some complex details in geometry which is difficult for conventional manufacturing, however, with the additive manufacturing technology, the complex geometry is no longer a barrier. The purposes of this research are obtaining simulation results of stress and total deformation of the racing quadcopter with each carbon fiber frame, PLA frame, and PLA frame after optimization and manufacturing "The best design" frame using the 3D printer. The methodology is started from the quadcopter modeling, initial simulation using the static structural simulation of finite element software. Continued by topology optimization simulation with some retain masses to obtain some redesign models. The next stage is the final simulation on the redesign models using the same method as the initial simulation, then the analysis is established to achieve "The best design". The last stage is model manufacturing using 3D printer, model testing, and result evaluation. As the result, "The best design" is achieved from doubling thickness of PLA frame establishing redesign of 60% retain mass topology optimization. Then both "The best design" manufacturing and testing are done well although with some defects.

Keywords: *3D Printing, Finite Element, Frame, Polylactic Acid, Quadcopter, Topology Optimization, UAV*

Design and Analysis of Regenerative Shock Absorber Using Ball Screw Mechanism for Vehicle Suspension

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Abstract. This paper presents the modelling and analysis of Regenerative Shock Absorber (RSA) using ball screw mechanism. The RSA design converts reciprocating linear motion of vehicle suspension with ball screw. With bevel gear and one-way bearing, the bidirectional rotation converts to unidirectional rotation and the power will be simultaneously generated. The RSA ball screw was modeled and simulated to study the characteristic, performance, and power generated. With various excitation frequency, the RMS power generated was 22.47 W and maximum power 36.4 W at 3 Hz was achieved.

Keywords: *Regenerative Shock Absorber, Energy Recovery, Ball Screw, Vehicle Suspension*

Effect of Surface Treatment and Grain Boundary Orientation to The Changes in Stents Surface Roughness

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Abstract. During the implantation process, an expandable balloon stent undergoes a change in mesh shape with a high strain rate. Permanent mesh shape changes to the stents indicate plastic deformation has occurred. On a micro scale, plastic deformation has a significant influence when interacting with the soft tissue of human blood vessels. This experimental study aims to investigate the effect of surface treatment on the stents and the boundary orientation of the stent material grains on the changes in surface roughness that definitely occurs when a stent deployed. There are three types of specimens prepared, according to standard specimens for tensile tests. To study the effect of surface treatment, two types of surface treatment were given to specimens: etching and electropolishing. The third specimen is left without any treatment as before cutting using wirecut. As for examining the effect of grain boundary orientation, the same stainless steel 316L plate were taken as specimens. In order to derive different grain boundary orientation, the plate was cut in lateral and longitudinal directions. An intermittent tensile test is carried out to obtain information on the changes in surface roughness of the specimens. The surface observation is carried out when the tensile load has yielded plastic deformation within the specimen. The experimental study show that grain boundary orientation has no significant effect to the changes in surface roughness. As for the surface treatments, etching provoked a higher hardness and electropolishing enhanced the tensile property of material.

Keywords: S*urface Roughness Changes, Grain Boundary Orientation, Plastic Deformation, Stent, Surface Treatment*

Analytical and Experimental Study of Translational Vibration Response's Reduction on Aluminum (Al) Drilling Process Using Translational Mass Vibration Absorber (TMVA) System

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Abstract. The metal working is the main sector of the manufacturing industry. There are many types of machine tools used in the manufacturing industry, one of them are drilling machine. Every working machine will definitely produce the vibration. The vibration that comes from a working drilling machine can reduce the effectiveness of the machine and cause the damage of machine components. And eventually reduce company productivity. The vibration from the drilling machine can be overcome by using Dynamic Vibration Absorber (DVA). The main system of DVA is the mass of absorber and the spring. This study is about an experimental study of Translational Mass Vibration Absorber (TMVA) which is one of Dynamic Vibration Absorber (DVA) types. TMVA is designed to be able to reduce the vertical vibrations caused by the rotational speed of drilling machine. The drilling machine used is Kao Ming Machinery Industrial Co., Ltd type KMR-700DS. TMVA has only vertical direction movement. TMVA is designed in the cylindrical shells made of acrylic. The TMVA consists of the absorber mass and a spring. The main systems of the drilling machine which were being observed in this study were the workpieces and the drill bits. TMVA was only placed on the workpiece during the drilling process. There were 2 variations used, that were the drill size variations and the TMVA mass ratio. The variations of drill size used were 8 mm, 10 mm and 12 mm. While, the variations of TMVA mass ratio were 1/40, 2/40, and 3/40 of the mass of workpiece, and it represented by 1,2, and 3 coins. The experiment carried out in two different conditions, that were the main system without TMVA and the main system with TMVA. The results are about vibration acceleration response, percentage reduction, surface of the drilling material, and the accuracy level percentage of the drilling diameter for each variation used. TMVA can reduce vibration at the rotational speed of 441 rpm and at the feeding speed of 0.07 mm/rev. Based on the experiment done, it can be concluded that the addition of 1/20 mass of absorber from the workpiece mass represented by 2 coins can effectively reduce the vibration in 12 mm drill size by 31.91%.

Keywords: *Translational Mass Vibration Absorber (TMVA), Drilling Machine, Reduction, Vibration, Translation*

Optimum Value Analysis of Vibration Response Reduction in Translational, Rolling, and Pitching Direction of the Primary System and Voltage Generation by Cantilever Piezoelectric Vibration Absorber (CPVA) Mechanism

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Abstract. The CPVA (Cantilever Piezoelectric Vibration Absorber) is a mechanism that combines working principles of DVA and energy harvesting to reduce vibration while generating voltage. The system's response that need to be reduced by the CPVA is a plat as a primary mass which has 3 degree-of-freedom those are translation, rolling, and pitching vibration direction. The objective of this study is to obtain the optimum configuration which provides the maximum vibration reduction while generate the optimum power. The variation of piezoelectric number and several nodes position where its mechanism is installed on the primary system need to be optimized in order to implement satisfactory performance. Simulation provides valuable insights in dynamical characteristics in each nodes and results the optimum value of the reduction and voltage generation in the 8th node position with the amount of 100 pieces of piezoelectric, which succeed for reducing translational, rolling, and pitching direction up to 79.8%; 76.1%; and 79.69% respectively.

Keywords: *CPVA (Cantilever Piezoelectric Vibration Absorber), Translation, Rolling, Pitching, Reduction, Vibration*

Hydro-Regenerative Shock Absorber with Two Generators in Series for Vehicle Suspension

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Abstract. This paper presents the design, modeling and fabrication of the prototype of Hydro-Regenerative Shock Absorber (HRSA) with two electric generators in series for vehicle suspension. The designed HRSA converts reciprocating linear motion of vehicle suspension into unidirectional fluid flow which turn the two electric generators in series and generate electricity. The HRSA is modeled and simulated to study the characteristic, performance, and the generated power. For further investigation, the prototype of HRSA is manufactured and implemented in the vehicle suspension. The results are discussed in this paper.

Keywords: *regenerative shock absorber, vibration energy harvesting, suspension energy recovery*

Radial Vibration Damper (RVD) Mechanism Validation for Long Thin Shaft at Lathe Machine

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Abstract. Currently, the metal working in manufacturing industry is growing rapidly, taking in mind that production activities cannot be separated from the use of machinery as a support for its operations. The excessive vibration will reduce the effectiveness of the engine, furthermore the engine will be irreparable. One way to reduce the excessive vibration from rotating shaft system at lathe machine is by using Radial Vibration Damper (RVD). This aims of this study are to reduce the vibration acting on a long thin shaft using RVD and to validate the experiment's results and simulation's results using the Independent T-test sample method. The position of RVD which is laid on a long thin shaft was varied. The working frequencies of the lathe machine were 320 rpm, 540 rpm, and 900 rpm. The results show that the simulation results correspond well to the experimental results. The maximum vibration reduction of a long-thin shaft occurred at the working frequency of 900 rpm for both the experimental method and the simulation method. The experimental results presented that the maximum vibration reduction of the shaft in the X-axis direction is 67.51% at point 4 (midspain) and the reduction in the Y-axis is 61.47% at point 3. While, the maximum reduction from simulation method occurred in the X-axis is 65.83% and in the Y-axis is 75.78%.

Keywords: *radial vibration damper (RVD), lathe machine, reduction, vibration, validation*

Girder Extension Effect on Earthquake Resilience of Ship Unloader Crane: A Numerical Study

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Abstract. The girder of a ship unloader crane (SUC) with a rated capacity of 1250 t/h has to be extended in order to follow jetty upgrading. The girder extension is limited by the railway span of gantry crane and the capacity of belt conveyor, which are maintained. This simulation aims to determine the effect of girder extension on the earthquake resilience. The simulation was carried out using ANSYS Mechanical APDL R19.1 based on the general arrangement drawing. To investigate the influence of earthquake impact on the SUC structure, three variations of girder extension is applied, i.e. 3 m, 6 m, and 9 m. The applied load consists of the SUC operating load and the earthquake load that works on the SUC structure's supports. The earthquake resilience of SUC after girder extension is evaluated by comparing the reaction forces that occur in the supports. The simulations indicated that the girder extension can reduce the earthquake resilience of SUC, depending on the direction of the earthquake propagation to the SUC.

Keywords: *earthquake resilience, girder extension, finite element method*

The Effect of Tuned Mass Damper to the Vibration of Wind Turbine Structure Model

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Abstract. The high generated power of the wind turbine requires stronger wind which is usually at high altitudes. The high constructions are vulnerable to external load such as strong wind. Therefore, it requires the system which can reduce the vibration caused by the wind force. Furthermore, the different form of the wind turbine's tower would affect the vibration of the wind turbine. The aim of this study is to compare the responses of vibration in three different form of wind turbine's tower. The effects of Tuned Mass Damper to each structure vibration were analyzed. The study was conducted both simulation and experimental method in a laboratory scale of the wind turbine model. The results show that the installation of TMD on the wind turbine model reduces the acceleration of the nacelle's mass. The vibration reduction is optimum at the frequency of 3 Hz.

Keywords: *tuned mass damper, vibration reduction, wind turbine vibration*

Dynamic Analysis and Control of Gyroscopic Inverted Pendulum

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Abstract. This study aims at modeling and control of inverted pendulum where the stabilization of the inverted pendulum is achieved by control torque generated by gyroscopic precession momentum. A nonlinear dynamic model is presented by using Lagrange method then linearized around its equilibrium point to obtain linear state-space model used to design the state-feedback controller. The dynamics analysis of the gyroscopic inverted pendulum is achieved through simulation experiment with Simscape Multibody, a multibody simulation environment for 3D mechanical systems. The simulation results show that the designed controller is able to stabilize non-linear system around equilibrium with great initial roll angle up to 90^0 and impulse disturbance.

Keywords: *inverted pendulum, gyroscopic precession, LQR controller, multibody simulation*

Noise Reduction for Passenger Vehicle Radiator Cooling Fan by Using Additional Plate and Material Dampers

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Abstract. The main source of noise in the car coming from the engine, but at this point the car industry has been able to apply the technology to reduce noise coming from the engine. Other sources of noise coming from the fan on the radiator. In the research, the method from reduction noise on fan of cooling system was developed.

The study was conducted using the fan radiator in a car Toyota All New Vios Type G with a voltage of 12 V and the number of blade 7. Tests were performed using a noise Sound level meter TENMARS TM-102 with units of dBA noise by using a 7-point semi-circle in front of the radiator. Variations are used there are some that variations in width blade dampers, variable-angle and distance between blades, and also variations in distance between the positions of absorbers with radiator. Blade width variation has 3 variations starting from a width of 4 cm, 6 cm and 8 cm. The variation of the angle of 0°-60° with a variation interval distance between slats 15°. starting from a distance of 2 cm to 4 cm by 1 cm intervals. And the last variation of the distance between the positions of absorbers with radiator at the start of the closest distance that is used on the radiator that is 8 cm to 12 cm at intervals of 2 cm.

Of the present study showed that of the use of damping material is placed in front of the radiator has the effect to reduce the amount of noise from the fan radiator. Different variations used in the present study had different results in the ability to reduce noise fan radiator of the car Toyota All New Vios Type G. The noise reduction obtained in this study of 6.9 dBA on the variation with wide blade damper 8 cm, angle of 60°, the distance between the slats 3 cm, and placed in the position of 8 cm between the radiator with a silencer.

Keywords: *radiator, fan, noise, blade, plate, damper*

Experimental and Numerical Analysis on Strengthening of 42-ft Flat Wagon

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Abstract. 40-ft flat wagon belongs to INKA Inc., needs an investigation related to solving the crack initiation problem on its metal construction. During 7 years of operation, there are no failures found in the structure of the 40-ft flat wagon, while it is used to transport any products equipped by the containers. However, a crack is found in the center sill after a year of cement transportation without using containers. Coupled experimental and numerical analysis is conducted to find a reinforcement. The restrictions for the reinforcement structure are the total weight of reinforcement cannot exceed 4 ton, the reinforcement design cannot disturb the loading path, and the maximum deflection cannot exceed 10 mm. The study suggested a simple reinforcement to be installed side-by-side existing construction.

Keywords: *reinforcement, flat wagon, rosette, size optimization*

Ball Bearing Fault Diagnosis Using Wavelet Transform and Principal Component Analysis

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Abstract. This study proposes a new method for fault diagnosis in ball bearings based on wavelet transform and principal component analysis (PCA) of the acquired vibration signals. The signals collected are pre-processed using a wavelet transform to decompose the signals into low (approximated) and high (detailed) frequency part where the high-frequency part are needed for fault diagnosis purposes. Eleven potential statistical features are then extracted from the high-frequency part coming from different bearing fault signals and those from healthy bearings as well. Four types of signals are proposed, they are outer race fault, inner race fault, ball fault and no-fault signals. The PCA is used to linearly transform and reduce multidimensional data resulted from statistical extraction down to a few dimensions for more straightforward analysis. Six principal components retaining more than 95% significance level are used for bearing fault detection and classification. By combining the wavelet transform, statistical features extraction and PCA, the proposed method successfully detected and classified fault types without knowledge of a bearing fault frequencies and analysis from experienced users.

Keywords: *bearing fault detection, waveley transform, principal component analysis*

Dynamic Analysis of Bangladesh Broad Gauge Train Using Multibody System

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Abstract. In the present work, the dynamic performance of the Bangladesh broad gauge train was numerically evaluated based on UIC-518 standard, which covers the analysis of critical speed of the vehicle, lateral-to-vertical (LV) force ratio, sum of guiding force per wheelset and acceleration of the carbody in response to good and bad track condition. Ride-comfort analysis and the impact to human health based on Sperling ride index criteria were also conducted. Parametric study was performed by varying the lateral and vertical stiffness of both primary and secondary spring. Internal damping of coil spring was calculated based on Den Boer's work with damping ratio of 28% for coil spring. It was concluded that Bangladesh broad gauge train dynamic performance has passed UIC standard. Modification of vertical stiffness of both springs affect the L/V ratio and vertical ride index, whereas the modification of lateral stiffness of both springs affect the critical speed, sum of guiding force, and lateral ride index of the train.

Keywords: *dynamic analysis, multibody system, Bangladesh broad gauge train, UIC standard*

Probabilistic Assessments of Fatigue Crack Growth Rate of TIG Welded Al 6013-t4 by Weibull Distribution Function

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Abstract. The limited data of fatigue crack growth (FCG) may cause the inaccuracy assessment of the fatigue crack growth rate (FCGR). For particular parts in aircraft such as fuselage skin, a high reliability degree due to FCG must be determined accurately for the design and safety requirements. Generally, the 6xxx series of aluminum alloy is used as the material for the fuselage skin in the aircraft. In this study, a probabilistic assessment of FCG data of TIG welded Al 6013-t4 under various aging time was evaluated by Weibull distribution function. The FCG tests were conducted by following the ASTM E647 under three different artificial aging time conditions of 6, 18, and 24 hours. The FCGR curves were generated from the FCG data and plotted on the da/dN vs. Δk curves. The C and m constants were analyzed by means of three methods; a least square fitting method (LSFM), a mean value method (MVM) and a probabilistic distribution method (PDM). The result showed that the PDM and MVM showed a better fitted line to assess the FCGR than LSFM. From the probabilistic viewpoints, the two-parameters of Weibull was proposed to be applied as the PDM. Furthermore, the reliability assessment of FCG data was evaluated by generating a large number of FCG data with a Monte-Carlo method and followed with a confidence interval determination. From the reliability assessment, the FCG data were lay on 5% and 90% of confidence interval.

Keywords: *Fatigue Crack Growth (FCG), Monte Carlo Method (MCM), weibull*

Analysis and Comparison of the Potentially Recaptured Kinetic Energy from the Vehicle Braking Process of Lock and Anti-Lock Brake System

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Abstract. The aim of this study is to analyze and compare the potentially recaptured kinetic energy from the vehicle braking process of Lock Brake System (LBS) and Anti-Lock Brake System (ABS). A Typical Multi-Purpose Vehicle (MPV) with engine capacity of 1.3L was used as the object of this study. The vehicle and its brake system was mathematically modeled and the dynamic responses were simulated. The car speed variation were 20 km/h, 40 km/h, and 60 km/h. Simulation method provided the performance of the vehicle such as braking distance, vehicle's speed, wheel's speed, and the braking's power. The simulation's results were compared to the experimental results. The results showed that the vehicle with ABS can reduce the braking distance about 13.5%. The error from simulation method was 0.45% and it is concluded that the simulation method correspond well to the experimental method. The validated dynamic model of vehicle's brake system was used to simulate and calculate the kinetic energy from the vehicle braking process. The highest power that can be achieved is 24.8 W-h at 60 km/h with ABS.

Keywords: *kinetic energy recovery, brake energy recovery, brake kinetic energy*

Simulation Study and Stress Analysis Conventional Pumping Unit Finite Element Method

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Abstract. Conventional pumping unit is an artificial lift widely used in oil and gas production. As the main function to lift oil from beneath surface to surface facility, most of pumping unit operating continuously to maintain production. However, some components failure during operation such as the fracture of bracket housing equalizer bearing and housing of equalizer pin. This paper aims to study stress analysis in pumping unit structure by analytical calculation of loading and simulate the effect to key components of structure conventional pumping unit. The mechanical performance of key components was simulated in Abaqus software with finite element analysis. Through the analysis of mechanical behavior in key components according to the simulation results, the damage mechanism of key components was obtained, and this provides a theoretical basis for the structural design and optimization of key components in conventional pumping.

Keywords: *pumping unit, finite element, simulation*

The Effect of Surface Contact on The Stress Distribution and Deflection of Airless Tire

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Abstract. This research aims to discover the deflection and tension on honeycomb-spoke airless tires. For this research, three contact point positions were determined to calculate the tension and deflection generated on airless tires. The values were then employed to observe the deviation of each contact point position. A simulation was run on each point by applying equal weight with the force of 4 kN, 6kN, and 8 kN,and spoke thickness of 4 mm, 5 mm, and 6 mm. It is acknowledged that airless tires with honeycomb cell sustain different tension and deformation on each contact point. However, in this simulation, the displacement was relatively very small. Based on this finding, the deviation would be unnoticeable during slow speed, and otherwise on high speed. The tension deviation on each point may cause different wear, meaning that the tire would wear out unevenly, lead by the part sustaining highest tension. However, in this research, the spoke tension was very small when compared to the allowed tension for tires.

Keywords: *spoke, airless, tire*

Multi Function Wheelchair

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Abstract. Abstract-A CAD model of a flexible wheelchair was developed. This work aimed to investigate the static stability of flexible wheelchair using anthropometry data of Indonesian. The centre of mass (COM) of wheelchair design and the human model were considered in calculating the static stability of wheelchair. The static stability of a wheelchair was evaluated after calculating the COM. The characteristic of stability of the wheelchair obtained by modifying the distance of the rear wheels central axis, the COM of the wheelchair design, and the human model as a body. The minimal distance of the COM for the wheelchair stability was obtained. The static stability of the wheelchair was also affected by the backrest inclination.

Keywords: *wheelchair, multifunction, human model*

Energy

Experimental and Numerical Study on The Boundary Layer Flow over a Flat Plate with a Semi-Circular Bump with and without a Transversal Wire

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Abstract. Flow behavior over a bump attached on a flat plate has significant effect on the total drag. The drag comprises of pressure and friction or viscous drags. Attaching a disturbance on the bump surface affects significantly on the contribution of pressure and viscous drag. This study is intended to examine the effect of a small wire (tripping wire) attachment on a semi-circular bump surface on the flow characteristics over the semi-circular bump. Special attention of this study is to examine the drag characteristics, pressure distribution, and boundary layer separation point from the bump surface.

The study was conducted using experimental and numerical methods. The experiments were conducted in a low-speed wind tunnel at a freestream velocity of 16.5 m/s, corresponding to the flow Reynolds number (Re) of approximately 2.1 x 105. Flat plates with a semi-circular bump with and without wire were attached in the wind tunnel test section used as model tests. The wire is attached at three different angle (θ) locations of the bump surface, namely θ = 30 deg, 40 deg, and 50 deg. The pressure distribution on the plate surface as well as on the bump surface is measured using static pressure taps connected to U-tube manometer. From the pressure distribution, then the pressure drag is obtained from the integration of pressure distribution on the surface. Fluid velocity is measured using a Pitot static tube. Numerical studies was conducted using a commercial software the Fluent. A 2-D, steady flow turbulent model k-ω shear-stress transport (SST) was used in this study. In the numerical simulation, the grid independency test is performed to ensure better results.

The results of the study show that the presence of a small wire attached on the bump surface increases to the total drag of the model for all values of θ. Also, the boundary layer separation point on the bump surface for all values of θ occurs at smaller angle comparing to that of the bump without wire. Results from the experimental study compare very well to the results obtained from the numerical simulations with a maximum difference of approximately 5 percent. In this study, the maximum drag occurs for the bump with the tripping wire attached at θ = 50 deg.

Keywords: *bump, boundary layer, separation*

The Exergy Analysis on Energy System of AC Split Application with Capillary Tube Incorporated Ejector and Dual Evaporator Temperature

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Abstract. Split air conditioning technology is commonly working with vapor compression cycle that still uses a capillary tube as expansion device. One of the thermodynamic disadvantages of the cycle is the isenthalpic expansion process which occurs in the capillary tube. The capillary tube also has the disadvantage of friction along the tube wall and can cause considerable energy losses. It has been reported that by replacing the capillary tube with a two-phase flow ejector system as an expansion device could improve energy performance of the air conditioning system. However the publication about the application of the ejector expansion for energy conservation goals in domestic split air conditioners system is still very limited. This paper presents a numerical comparison base on experimental data study between a conventional air conditioning system with capillary tube as the expansion device and two-phase systems using Condenser Outlet Split (COS) ejector.

One purpose of this study was to investigate the effects of temperature on the evaporator COS application of dual evaporator temperature and exergy destruction of energy system performance of a domestic split air conditioner. Its performance was compared with the conventional split air conditioning system. The exergy analysis based numerical model was developed which included one model for the proposed system which was a domestic split air conditioning system applying Condenser Outlet Split (COS) ejector. The model of the proposed system comprised the ejector cycle of two phases in a COS ejector incorporated capillary tube expansion devices. The downstream of the two expansion devices were connected to a dual temperature evaporator. The evaporator consisted of main flow section and sub-flow section which were downstream of the ejector and capillary tube expansion devices respectively. By using the models two different refrigerants used which are R-22 and R-290, The coefficient of performance of the ejector refrigeration system and the amount of irreversibility and efficiency of each of its components were determined and compared with those of a basic vapor compression refrigeration system. The results showed that COP of the proposed system with COS ejector system could perform better with a significant increase on the COP compared with the conventional split air conditioning.

Keywords: *dual temperature evaporator, energy performance, exergy analysis, split air conditioning*

Numerical Study of Three-Dimensional Flow Characteristics Around the Wing Airfoil E562 With Forward and Rearward Wingtip Fence

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Abstract. Airfoil is an aerodynamic model that is widely used both on aircraft wings, Unmanned Aerial Vehicle (UAV) and fluid machines such as pumps, compressors and turbines. Airfoil on aircraft wings with the resulting lift force is used to lift the entire aircraft. The pressure difference between the top and bottom of the airfoil on the wing causes the plane to gain lift. Increased performance of the airfoil on the wing can be done in various ways, one of which is adding a winglet to reduce drag. It is expected that with an increase in lift and a decrease in drag force will increase the performance of the aircraft. This research was conducted by numerical simulation using Ansys 19.0. with turbulent model k-ω SST. The freestream flow rate used is 10 m / s (Re = 2.3 x 104) with the angle of attack (α) = 0º, 2º, 4º, 6º, 8º, 10º,12º,15º, 16º,17º,19º and 20º. The specimen model is an Eppler 562 (E562) airfoil with and without a winglet. From this study, tip vortex were seen in plain wings at high speeds and at rearward wingtip fence with lower speeds. In the area that has been separated (wake) which is indicated by a lower speed in plain wing x = 1c. In the z = 1.5c area, it is shown that there is a pathline difference between the three models showing the influence of the three-dimensional flow on the rearward wingtip fence where there is a higher velocity in the upper surface area. In the trailing edge z = 1.9 shows that there is a pathline from the lower surface to the upper surface in the plain wing and rearward wingtip fence.

Keywords: *airfoil, eppler 562, forward wingtip fence, rearward wingtip fence, tip vortex, winglet*

Numerical Simulation Analysis of Supersonic Asymmetric Converging-Diverging Nozzle with Stepped Curvature and Curved Geometries

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Abstract. A numerical simulation, using the Cartesian and Body Fitted Coordinate (BFC) structured mesh, has been conducted to investigate a fluid dynamic inside the asymmetric supersonic Converging-Diverging (CD) nozzle. Two types of nozzle contour geometry, namely stepped curvature and curved, was simulated to obtain the flow parameters and turbulence properties. The turbulence model of Standard (STD) k-ε has been applied to solve the two planar nozzles with 3510 cells of stepped model and 3298 independence grid cells of curved model. The result of flow parameters such as distribution of pressure, temperature, density, and Mach number (Ma) was theoretically verified for satisfying the compressible flow analysis. It was obtained that there was a difference between the stepped and curved geometry, in case of flow properties, inside the divergent section of nozzle. The existence of stepped contour has resulted in gaining the static pressure, as the consequence of friction loss, thus influencing the turbulence properties such as turbulent kinetic energy and dissipation rate, as well the occurred shock structure.

Keywords: c*onverging – diverging nozzle, curved geometry, numerical simulation, stepped curvature, supersonic*

Thermodynamic Investigation of Automotive Air Conditioning System Performance Using Ejector as an Expansion Device

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Abstract. The use of ejector as an expansion device in an automotive air conditioning (A/C) system is to enhance the system performance. The diameter of ejector motive nozzle is influenced by the cooling capacity of A/C. Meanwhile, the cooling capacity of automotive A/C air is affected by engine rotation. As a result, the diameter of ejector motive nozzle is not constant in the automotive A/C when the engine rotation changes. The present study determines the diameter of ejector motive nozzle for three cooling capacities, i.e. 2.5, 3.5 and 4.5 kW. These cooling capacities represent low, medium and high velocities of the automotive respectively. Besides varying the engine rotation, the study also varies the condensing temperatures at 40, 45 and 50oC. Based on the numerical approach, diameters of ejector motive nozzle for three velocities at the condenser temperature of 40oC are 1.529, 1.809 and 2.051 mm, respectively. The numerical results show that the use of ejector as an expansion device in automotive A/C decreases the cooling capacity and the input power of the automotive of A/C. However, due to dominant decrease in input power as compared to the decrease in cooling capacity, the coefficient of performance (COP) of the A/C increases. In addition, higher ambient temperature also causes an increase in COP of the A/C. At the condensing temperatures of 40, 45 and 50oC, the COP improvements are 9.38, 22.49 and 33.20%. It indicates that the COP improvement is optimal at high ambient temperature.

Keywords: *automotive air conditioning, condenser temperature, ejector, expansion device, motive nozzle diameter*

Analysis of Heat Transfer and Pressure Loss of Fluid Flow through Perforated Concave Delta Winglet Vortex Generators in a Rectangular Channel with Field Synergy Principle

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Abstract. A compact heat exchanger can be found in air conditioning, automotive industry, chemical processing, etc. One type of compact heat exchanger is fin and tube where gas as a medium of heat exchange. However, gas has high thermal resistance, which affects the low rate of heat transfer. The thermal resistance on the gas side needs to be reduced by increasing the heat transfer coefficient of convection. Enhancement of the convection heat transfer coefficient can be done by using the vortex generator. Vortex generator is a manipulator of flow to improve the convection heat transfer coefficient by increasing the mixture of air near the wall with the air in the main flow. Therefore, this study aims to analyze the characteristic of heat transfer and pressure drop through perforated concave delta winglet pair vortex generator inside a rectangular channel. This study was conducted on delta winglet pair vortex generator (DWPs) and concave delta winglet pairs vortex generator (CDWPs) with the 45º angle of attack with a number of hole three-holes that applied on every vortex generator with one-line fitting, two-line fitting, and three-line fitting respectively. Result of simulation revealed that convection heat transfer coefficient for concave delta winglet with three-hole and three-line fitting configuration decrease 16.07% and pressure drop decrease 7% compare to three-line fitting without hole configuration at Reynolds number 8600. Convection heat transfer coefficient for delta winglet with three-pairs of vortex generator three-hole decrease 13.76% and pressure drop decrease 5.22% compare to three-pairs delta winglet without hole configuration at Reynolds number 8600.

Keywords: *field synergy principle, heat transfer, longitudinal vortex, perforated concave delta winglet, pressure drop*

The Study of The Aerodynamic Effect of Motorcar Rear Wing Using Computational Simulation

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Abstract. This research project deals with the analysis study of an aerodynamic to the car model with and without using rear wing. The objective of this research is to develop the computational modeling of the car with and without rear wing and running it into analysis software to evaluate the performance drag and lift coefficient of the car with and without rear wing or spoiler and get the best result from it. CATIA V5 and Solidworks Flow Simulation selected in this research project as to design and make an analysis of a model. The Ford Mondeo year 2000 is being selected as a model in this research project and need to find the blueprint to put in CATIA V5 to design it. The rear wing design has five design with various dimension of it to be simulate. The simulation of the car with and without rear wing or spoilers design using Solidworks Flow Simulation and the designs is running on external flow with density is a 1.184 kg/m^3 and velocity is 30 m/s. the data collected for this research project is drag force, lift or down force, drag coefficient, lift coefficient, flow trajectories and cut plot of the design.

Keywords: *computational modelling, drag coefficient, lift coefficient, rear wing*

Effect of Natural Gas Injection Timing on Combustion Performance & Methane Slip Emission of Diesel – NG Dual Fuel Engine : an Experimental Study

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Abstract. Development of marine engine technology is driven increasingly by strict emissions regulations. Dual fuel technology which uses natural gas as supporting fuel is a smart solution due to it is cleaner, cheaper and can reduces dependency on fossil fuel oil. However, the phenomenon of methane slip is the biggest challenges on applications of diesel – natural gas dual fuel engine. A large amount of fuel with poor oxygen especially when engine on low load condition make some parts of methane were unburned, these uncompleted combustion raises methane slip. Meanwhile crevice or dead volume in the cylinder make gas trapped and come out as exhaust gas without participating on combustion. It is evident that being the same greenhouse gases the effect of methane slip is more dangerous than CO_2 causing global warming and climate change. This research was carried out experimentally to find out how the natural gas injection time affected on the combustion performance and methane slip. On this study, four variation on injection timing of natural gas 260 BTDC, 244 BTDC, 230 BTDC and 214 BTDC was investigated to single cylinder diesel engine on constant speed. The pressure of gas injection was taken fixed 3 bar, while the pilot injection timing was constant at 18 BTDC. BMEP, thermal efficiency, heat release, cylinder pressure and methane emissions were taken at a constant rotation of 2000 rpm. The results indicated that engine performance increases as increase of load. While the best thermal efficiency value was on start of injection (SOI) 230 BTDC which directly proportional to the percentage energy substitutions (PES) and DEX substitutions which reached optimal conditions on average percentage 65% and also the methane slip.

Keywords: *dual fuel, heat release rate, in cylinder pressure, methane slip, start of injection*

Influence of Thermal Cycling of Cold Rolled Stainless Steel 316L onto Hardness and Microstructures

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Abstract. Investment casting of orthopedic broad plate implant based on stainless steel AISI 316L was considered an economical process as compared to other manufacturing processes. Nevertheless, the mechanical properties of the investment casting product were found to be lower as compared to implant produced using hot forging method. In order to improve their mechanical properties, the investment casting implant broad plate was cold-rolled up to 50% reduction in thickness and then thermally cycled to initiate recrystallization of the new grain of AISI 316L. These processes will increase the strength and hardness of the material without sacrificing ductility or toughness. It was found that thermal cycling treatment at a temperature of 950 C for 35 seconds within four cycles will aid recrystallization of the new grain of 22 µm in size as compared to investment casting grain size of 290 µm. The hardness also increases from 139 HV1 in investment casting product to 253 HV1 after thermal cycling. Lower thermal cycling temperature did not alter the microstructure indicating that no recrystallization happens during treatment and only residual stress relieve that was taking place.

Keywords: *316L, cold rolling, investment casting, thermal cycling*

3D Reconstruction of Rolling Contact Fatigue Cracks in Rails with Tight Serial Cutting

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Abstract. Rolling contact fatigue (RCF) crack is one of the crucial issues in rail condition monitoring. This type of crack is occurred in the rail and can be a threat that leads to a fatal accidence, such as rail breaking. In order to study this crack, effort on revealing its full structure has been an attentive topic. In term of destructive technique, computed tomographic (CT) technique and serial cutting are two common methods to study RCF crack structure. In this study, a tight serial cutting of a cracked spot from a used rail sample has been done. The rail sample was cut from Akeshov, Sweden. The rail was sliced into 0.65mm-thick identical pieces with 0.35-mm thick electrical discharge wire (EDM). From the sliced pieces, a 3D RCF crack image has been reconstructed. Due to tight slicing, the structure of crack can be observed clearly and thus its angle, depth, network, branches and profile can be analysed. This method seems promising to verify defect measurement with non-destructive technique, such as ultrasonic measurement and eddy current testing. Other mechanical characterisations can also be performed with this 3D image crack reconstruction.

Keywords: *3D image reconstruction, rolling contact fatigue crack, railyway, near – surface crack*

Friction and Wear Performance of Phosphonium-based Ionic Liquid Additives in Glycol Media

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Abstract. Ionic liquids (IL) have been widely discussed as potential lubricants, however, they can also be potential candidates as lubricant additives like friction modifiers (FM) and anti-wear (AW). In this study, three phosphonium-based IL candidates as FM and AW additives have been investigated: tributylmethylphosphonium dimethylphosphate (PP), trihexyltetradecylphosphonium bis(2,4,4-trimethylpentyl)phosphinate (PB), and trihexyltetradecylphosphonium decanoate (PC). Diethylene glycol (DEG) was used as the base lubricant. The effects of cation alkyl chain length and types of anion on tribological performance were investigated using unidirectional pin-on-disk tribometer under boundary conditions at room temperature and 75ºC. Dodecanoic acid (C12) was selected as a reference additive because it is a widely used friction modifier. From this study, C12 reduces both friction and wear rate in DEG media. PP which has a shorter alkyl chain in both cation and anion shows an increase in both friction and wear. On the other hand, longer alkyl chain IL like PB and PC, demonstrated effective friction modifier and anti-wear performance, where decanoate anion seems to give the lower coefficient of friction but higher wear rate compared to phosphinate anion.

Keywords: *diethylene glycol, phosphonium – based ionic liquid, boundary additives, friction, wear*

The Effect of Acidity and Rotation Speed in Titanium Dioxide Synthesize Process

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Abstract. The aims of this study are to analyze the effect of acidity and rotational speed in the synthesis of TiO^2 using the sol-gel method and to analyze the morphology of synthesized TiO_2 nanoparticles and commercial TiO_2 using XRD to produce semiconductors for Dye-Sensitized Solar Cell (DSSC) applications. The sol-gel method was used to synthesize TiO_2 Nanoparticles. Titanium tetra-isopropoxide (TTIP) was used as a precursor with the variable of the magnetic stirrer rotation speed of 500, 1000 and 1500 rpm. Acidification was achieved with adding acetic acid to Sol-gel solution to produce a pH number of 1, 2, and 3. Nanomaterial was observed with an optical microscope and X-ray Powder Diffraction (X-RD) to determine the morphology and phase of TiO_2 crystalline. The results showed that the rotational speed and acidity level of the Sol-gel solution ware played an important role to get the best form of a nanoparticle. At a rotation speed of 1500 rpm with pH 3 and 1000 rpm with pH 2 ware shown characteristics similar to commercial TiO_2. In addition to that, the results of XRD characterization of synthesized TiO_2 was shown a crystal phase of anatase structure with 18,046 nm crystal size compared to commercial TiO_2 with anatase structure and crystal size of 15,554 nm.

Keywords: *dye-sensitized solar cell, sol – gel, XRD*

Fabrication Membrane of Titanium Dioxide (TiO2) Blended Polyethersulfone (PES) and Polyvinilidene Fluoride (PVDF); Characterization, Mechanical Properties and Water Treatment

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Abstract. In this research, Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) with addition Titanium Dioxide (TiO_2) blended membranes are prepared using the DC 15000 V electric field method. Investigated of this research were effects of the addition of Titanium Dioxide (TiO_2) and DC electric field methods such as the mechanical properties of membranes and water treatment performance. The surface of Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) blend membrane obtain were characterized using SEM, The membrane pore size shrinks and forms evenly with the addition of Titanium Dioxide (TiO_2) and the DC electric field method. The tensile test was performed to obtain the mechanical properties of Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) with addition Titanium Dioxide (TiO_2) blend membrane, which showed an increase in the optimal tensile strength to 3.86 MPa at a concentration of 30% Polyethersulfone (PES) and also increased up to 1.15 MPa at 20% Polyvinylidene Fluoride (PVDF). The surface of the membrane was examined using contact angle measurements, which in the Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) blend membranes showed a decrease angle between the range 43º - 46º. Therefore, hydrophilicity permits to suppress pure water permeate flux. The membranes fabrication with the addition of Titanium Dioxide (TiO_2) and assisted by the DC electric field opens up new ways to increase membrane strength, hydrophilicity, shrinks and makes formed evenly pore size.

Keywords: *polyethersulfone, polyvinylidene flouride, titanium dioxide, flat sheet, electric field*

An Experimental Investigation of Geopolymer Composite Reinforced with by Short Carbon Fiber

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Abstract. Since its introduction in the 1970s, geopolymer composite technology has been progressing rapidly with various improvisations. But its use is still limited to building materials with additional sand and coral. This research presents the mechanical properties of geopolymer composites for other applications, such as pipes, by replacing sand and corals with carbon fiber. Geopolymers consist of fly ash, kaolin, silica fume and calcium oxide which are activated with sodium silicate. To increase the mechanical strength, 2 cm carbon fiber is added randomly with varying percentages. Experimental design and analysis were performed by Taguchi method to obtain 16 specimens with various compositions. Samples were tested by bending three-point test (ASTM C1161), XRF, SEM-EDX, and XRD. The test results showed that the 5 best samples were T8, T7, T16, T15, and T11. The best flexural strength is about 86 MPa and flexural modulus is 20 GPa with composition: FA 50%, K 40%, SF 10%, CaO 4% and carbon fiber 15%.

Keywords: *geopolymer, fly ash, carbon fiber, flexural strength, pipe*

Low Cycle Fatigue Properties of Aluminizing Coating on Cold-Drawn AISI 1018 Steel

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Abstract. The cold-drawn AISI 1018 steel (CDS 1018) was coated by hot-dipping aluminizing coating (HDA steel). The mechanical properties and the low cycle fatigue (LCF) properties of the CDS 1018 and HDA steel were investigated at room temperature. The aluminide coating on a CDS 1018 significantly decreases the mechanical properties and the strain-fatigue life of the material. By increasing in strain amplitude levels, CDS 1018 experienced a continuously cyclic softening behavior after a cyclic loading in few cycles. In contrast, the cyclic softening of HDA steel was observed in the first few cycles and continuously the HDA steel exhibits the stable cyclic behavior until failure. The aluminide coating on CDS 1018 results a higher optimization fatigue cycles than those of CDS 1018 without aluminide coating by a factor of ~3.0.

Keywords: *cold drawn aisi 1018 steel, aluminizing coating, strain – fatigue life, cyclic softening, cyclic hardening*

The Performance of Carbide Waste as an Adsorbent to Reduce Spark Ignition Engine Emission

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Abstract. The utilization of waste as an adsorbent has been proposed as one approach to reduce emission from spark ignition engine. In order to improve the air quality due to the fuel combustion from SI engine the utilization of adsorbent in exhaust line could be a solution. For that purpose, carbide waste has been used which functions as adsorbent and was placed in the engine exhaust line. Three adsorbent casing in length were used they are 50, 100, and 150 mm. The results showed that improvements on engine emissions have been gained as a result of the utilization of carbide waste in the exhaust pipe compared to that of without treatment. An improvement of 57% and 50% on CO and HC respectively were obtained as a result of the utilization of carbide waste. Through surface morphology analysis it was clear that the emissions were adsorbed by the carbide surface. Therefore, the longer adsorbent casing the better emission results were obtained.

Keywords: *carbide waste, emissions, adsorbent, SI engine*

Investigation of PEM Fuel Cell Performance Using the Bio-Inspired Flow Field Combined with Baffles on Branch Channels

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Abstract. The issue of limited petroleum reserves and air pollution concerns encourage researchers to innovate new design of energy conversion machines with alternative energy sources and environmentally friendly. The fuel cell is one of the technologies that can be chosen because fuel cells use hydrogen as an energy source to be converted into electrical energy directly. The design of flow fields is an important factor that influences cell performance, the use of baffle in the channel in the flow field is also proven to be able to improve PEM fuel cell performance. Therefore, in this study, we investigated the effect of using baffles on branch channels in the flow field inspired by leaf towards cell performance. This study was carried out by numerical simulation method using Ansys Fluent software. The area of active PEM fuel cell used is 25 cm². The design of the serpentine flow field is used on the anode side, while on the cathode side the leaf shape design is used. Spacing between baffles is set based on the height of the baffle (h = 0.5 mm) which is 10h, 20h, and 30h. The baffles are also installed on the mother channel to block the flow directly to the output. The use of baffle can increase current density significantly compared to without baffle, up to 15%. Baffle spacing on branch channels does not affect cell performance at the macro scale. But on a more precise scale, the difference in performance can be seen.

Keywords: *PEM, fuel cell, bio-inspired, leaf shape, flow field, baffle, performance*

The Experiment Study of Performance of Air Heater Solar Collectors Type Dimple Inline Plate V-Corrugated Absorber

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Abstract. The availability of fossil energy sources is increasingly limited because of the uncontrolled use, so alternative energy is a need as a substitute for fossil energy, one of which is solar energy. Solar energy is used as a heater or dryer, in this case, a solar water collector. Solar air collector is one of the heat exchangers that converts solar energy into heat energy. The performance of the solar air heater collector can be improved in several ways, namely changing the shape of flat plate absorber to v-corrugated with an inline dimple to expand the absorption area and heat transfer on the absorber plate. Some researchers report that with v-corrugated absorber plates providing better heat transfer than flat plates and others also finding that the addition of dimple can increase the heat transfer area in an air heater solar collector compared to a flat plate. The diameter of the dimple used is 5 mm; 7 mm; and 9 mm; in the direction of the working fluid flow under the absorbent plate. The experimental results show the highest high heat transfer on the v-corrugated absorber plate with a 9 mm dimple diameter at a mass flow rate of 0.9468 kg/s with a radiation intensity of 719 Watt/m2 which is equal to 57.9^{o}C. The lowest heat transfer on the v-corrugated absorber plate with an inline dimple of 5 mm at a mass flow rate of 0.9468 kg/s with a radiation intensity of 431 Watts/m2 which is equal to 34.3^{o}C.

Keywords: s*olar heating air collector, v corrugated absorber plate, dimple diameter, efficiency, solar collector*

The Effect of Injection Timing of Diesel Engine Using Emulsified Fuel on Engine Performances and Exhaust Emission

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Abstract. Replacement of diesel fuel with emulsion fuel is one way to overcome exhaust emissions from combustion, especially smoke emissions and increases combustion efficiency. This study used an emulsion with a mixture of 35% water and 65% diesel. The study used a Diamond DI 800 diesel engine by varying injection times by 13oBTDC - 19oBTDC intervals of 2oBTDC with loads of 1000 W (low load) and 4000 W (high load). The engine rotation was kept constant 1500 rpm. The results showed that despite a decrease in exhaust emissions and an increase in combustion efficiency, the value of thermal efficiency increased by 50.3% compared to standard diesel fuel at 17oBTDC. Smoke emissions decreased by 2.53%. it was accompanied by an increase in fuel consumption, under standard conditions fuel consumption increased by 15%, but by advancing injection time, fuel consumption decreased to 8.7%, low engine torque and power decreased by 3.17% with max output 3,056 HP.

Keywords: *water in diesel emulsion, injection timing, emissions, diesel engine, combustion*

Experimental Study of Performance of Scroll Type Expander in Organic Rankine Cycle (ORC) with R-141b Working Fluid

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Abstract. Waste heat is the unused-product of every process that uses energy and machinery to do work. One effort to utilize the low and medium temperature waste heat to produce electrical energy is to use the Organic Rankine Cycle (ORC) system. ORC consists of 4 main components, namely: evaporator, turbine/expander, pump, and condenser. In this paper, simulation and experiment methodology have been illustrated. The simulation is carried out by doing an Organic Rankine Cycle simulation using ASPEN Plus software to obtain net power and system efficiency. First stage simulation is comparison of 4 types of working fluids, namely R11, R123, R141b and R245fa. The boundary conditions are outlet temperature of evaporator 100°C and air temperature 30°C with variations in evaporator outlet pressure. The second stage is to simulate the variations of the superheating degrees and mass flow rates. The results achieved through analysis of the simulation process, obtained R141b as the selected working fluid. The experiment on ORC system with R141b working fluid, by varying the superheating degrees and mass flow rates is the next stage after conducting a simulation analysis. Experimental data was analyzed to obtain expander performance and ORC system compared to simulation results.

Keywords: *waste heat, organic rankine cycle, ASPEN plus, degree of superheating*

CFD Simulations of Complex Fluid Flow in Gas-Solid Fluidized Bed using Modified k-epsilon Turbulence Models

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Abstract. This work studies the effect of kinetic Prandtl in the k-ε turbulence model transport equation on the characteristics of fluidized bed fluid flow. The research was conducted using CFD simulation method. Three kinetic Prandtl values are chosen, namely 0.8; 0.9 and 1.1; plus 1 which comes from the default value of the turbulent model. The parameters observed were the difference in pressure in the bed, and several turbulence parameters, i.e. the rate of dissipation, the effective viscosity of the gas and the effective viscosity of the particles. The turbulent model with k-Prandtl of 0.9 gives the most accurate results at the superficial velocity range of 0.40 m/s - 0.70 m/s, while k-Prandtl of 1.1 gives most accurate results at the superficial velocity range of 0.80 m/s - 0.90 m/s. It is found that the decrease in the k-Prandtl value causes the decrease in the dissipation rate; same phenomena with effective viscosity of gas. It is also found that there was no significant change in the particle's effective viscosity with the change in k-Prandtl.

Keywords: *turbulence model, CFD, turbulent parameter, fluidized bed, kinetic Prandtl*

Numerical Study and Unsteady Savonius and Icewind Turbine Blade Design in FSI Method

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Abstract. Wind turbine performance can be increase by using optimum shape of blade. Meanwhile some Savonius wind turbine simulation is using constant angular velocity as input data. The value of constant angular velocity can be obtained from experimental data. Angular velocity should be resulted by interaction between fluids around wind turbine which change moment of inertia. Rotation of wind turbine can be simulated with fluid structure interaction in 1 degree of freedom method. This study is using straight Savonius and Icewind turbine. In steady and unsteady simulation, fluid defines as incompressible, viscous, and uniform air which flow from inlet free stream. Simulation object rotate in 1 degree of freedom in overset mesh area. Icewind turbine generates high number of coefficient power when it rotates by inlet free stream below 4 m/s. This phenomenon is affected by unsymmetrical shape of Icewind which allowed fluid flow behind reversing blade and sweep away wake area. Savonius wind turbine, which accomplished with endplate and overlap, rotate in high angular velocity and generate highest value of coefficient power. Vortex among advancing blade are flow trought overlap. This stream flow and fill empty area and reduce backflow behind reversing blade.

Keywords: *savonius wind turbine, icewind turbine, fluid structure interaction, coefficient power, tip speed ratio*

Numerical Study of the Characteristics of Flow and Heat Transfer Design of USC 1000 MW Superheater Boiler

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Abstract. Indonesian electricity demand increase average 8.3 % every year, from 236 Twh in 2017 to 480 Twh in 2026, this causes the state-owned electricity generation company looking for efficient, reliable , economical and clean power plant. therefore various Steam Power Plants (PLTU), and other power plants are built with the latest technology as part of the national strategic program of 35,000 MW by the Indonesian government. The state-owned electricity generation company is managing a project for the construction of the PLTU Java 9-10 USC 2 x 1000 MW in Banten, so the authors need to evaluated the flue gas flow characteristics and heat transfer process of the boiler with the latest technology. Steam Generators with the latest technology of this kind will be increasingly developed on Indonesia and other country in the future. The boiler data generally refers to the feasibility study, bidding document and documents related to the Java 9-10 PLTU that is currently in a construction project, this thesis uses a numerical approach to Computational Fluid Dynamic (CFD) to obtain the characteristics of flue gas flow and heat transfer from flue gas to the boiler tube on the superheater and modeling the heat transfer process from the flue gas to the tube boiler and the distribution of the regulation in various conditions that will be used as a reference evaluating the boiler detail design Ultra Super Critical Coal Fired Power Plant (USC CFPP) which will be submitted by the EPC so that a power generator company can obtain performance as expected and operated the power plant well.

Keywords: *boiler, heat transfer, ultra super critical coal fired power plant, computational fluid dynamic(CFD)*
Influence of Water Diesel Emulsion on The Performance and Emission Diesel Engine Under Varying Engine Load

Influence of Water Diesel Emulsion on The Performance and Emission Diesel Engine Under Varying Engine Load

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Abstract. One cylinder diesel engine operates using water emulsion diesel fuel with a percentage of 30% water and 35% by volume and diesel fuel as a comparison. Diesel operates at speeds of 1500 rpm and the engine load is 800-4000 watts at 400-watt intervals. The results of research on engine performance are torque, power, specific fuel consumption, and thermal efficiency. Combustion performance presented in the form of heat release rate and cylinder pressure. The results showed that fuel consumption and thermal efficiency decreased due to the percentage of water present in the fuel. While HC and CO emissions increase with the increase in the percentage of water.

Keywords: *water diesel emulsion, combustion, diesel engine, engine performance, emission*

Experimental Study Effect of Classifier Pulverizer Opening Setting Variation on Fineness Production Passed 200 Mesh for Berau Coal in Unit 6 of Suralaya Steam Power Plant

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Abstract. Suralaya Steam Power Plant is a coal-fired steam power plant with coal design, Bukit Asam. Currently in fulfilling coal needs using coal from East Kalimantan (Berau Coal). With the change of coal like that there will be changes in the characteristics of coal. Changes in the characteristics of coal have an impact on changes in the performance of special in pulverizer and boilers. The most significant change in characteristics is a change in the calorific value of coal and the Hardgrove Grindability Index (HGI). With these changes it will affect the flow of coal and the size of the fineness that passes 200 mesh. Both of these have an impact on the operating parameters of the generator which increase the superheater spray flow, the reheater spray flow and the exhaust gas temperature. The increase in superheater spray flow, reheater spray flow and exhaust temperature can be minimized by resetting to the pulverizer classifier to improve pulverizer performance and improve air and fuel ratio (Air Fuel Ratio). For this reason, this thesis uses the experimental method. This experiment was carried out by testing the variations in factory air fuel ratios of 1.7: 1, 1.8: 1 and 1.9: 1. The testing process for variations in factory air fuel ratios was also combined with variations in the opening angle of the vane Pulverizer classifier at an angle of 40%, 45%, 50%, 55% and 60%. The test is carried out at a fixed load of 600 MW. The initial results of this experimental test were used to analyze the combustion reaction process that occurred. Experimental data, namely the generator operating data logger and manual recording are then used to make the test baseline graph testing the superheater parameters and reheater spray flow and influencing the exhaust gas temperature at the generator. This thesis will determine the right settings for the change in viewpoint of the vane Pulverizer and the arrangement of the Primary Air Fuel Ratio and the Secondary Air Fuel Ratio. Later, the test results will be used as the basis for combustion tuning in unit 5-7 of boilers, especially unit 6.

Keywords: *pulverizer, primary air fuel ratio, classifier vane angel, hardgrove grindability index*

Analysis and Optimization of a 400 MW Coal Fired Power Plant Under a Proposed Low Rank Coal with Flue Gas Recirculation Mode

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Abstract. There are several ways to improve performance of coal fired power plant, one of them is flue gas recirculation (FGR) system. It can improve performance power plant especially at load lower than MCR. FGR increase flue gas quantity entering superheater and reheater at lower load to improve convection heat transfer. Further study is needed to evaluate the effect of FGR if the boiler using different coal from medium rank coal (MRC) to low rank coal (LRC), and the effect of FGR if the flue gas extraction proposed from economizer outlet and reheater outlet. This study varies power plant operation from MRC to LRC applying thermodynamics analysis and modeled through Cycle-Tempo software. There are three case simulation, the first model without FGR (Case 1), the second model using FGR where flue gas extraction is from economizer outlet (Case 2) and the third model using FGR where the flue gas extraction is from reheater outlet (Case 3). The power plant load variation are 100% MCR, 75% MCR and 50% MCR. Based on the heat balance and equipment design of a 400 MW Steam Power Plant at Banten-Indonesia. Preliminary result this study at Cycle-Tempo simulation with FGR ratio 10% using 5242 kcal/kg (MRC), net efficiency 36.52%, at 400 MW, 25.80% at 300 MW, 15.08% at 200 MW.

Keywords: *flue gas recirculation, coal fired power plant, low rank coal, cycle-tempo*

Numerical Study of Flow Characteristic and Heat Transfer on High Pressure Turbine Forced Cooling Process of PLTU Lontar

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Abstract. Repairing turbine equipment at the power plant in several cases of failure requires a unit shutdown and turning gear stop. Turning gear stop on the turbine allowed when the temperature of the high-pressure inner cylinder under 130° C. To achieve the minimum temperature of turning gear stop takes about 8 days with a natural cooling process. Considering limited maintenance time, forced cooling is carried out by deliver residual steam in the boiler and air through the boiler with a temperature lower than the temperature of the high-pressure inner cylinder into the turbine. Forced cooling on the turbine using residual steam and air from inside the boiler can be done by considering the cooling rate of the turbine blade material and the turbine inner casing. Rate of distribution and decreasing temperature are simulated using a numerical approach with Computational Fluid Dynamic (CFD).

Keywords: *Heat Transfer, HP Inner Cylinder, Forced Cooling, Computational Fluid Dynamic (CFD)*

Experimental Study The effect of the variation of the Mill Air Fuel ratio on fineness in the Pulverizer unit 6 of the Suralaya Steam Power Plant

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Abstract. The Suralaya steam power plant is a coal-fired steam power plant consisting of seven units with a total capacity of 3400MW. Where electricity is generated from electric generators that are rotated by steam turbines. Based on the boiler type, Suralaya steam power plant is a power plant of type "front rear fried pulverized coal boiler". In the design of solid fuels that are widely used in the steam power plant are coal, especially subbituminous species containing carbon around 55% - 86%. There is a change in the number of feed rate (coal flow) from coal usage which is different from the design. At loads between 500-600 MW (Full Load load) the feed rate increases by 25.91 T / h by using Berau coal, the coal feed rate is strongly influenced by the capacity and performance capabilities of the pulverizer. Decreasing performance of the pulverizer is characterized by 200 mesh quality passes from fineness / pulverized coal which is greater than 70% which results in an increase in metal temperature at the Secondary super heater. Experimental tests were carried out with the object pulverizer "C" in unit 6 of the Suralaya steam power plant to determine the relationship of coal characteristics and mill air fuel ratio to the quality of pulverized coal by regulating the setting of the comparison of coal flow and primary air flow with variations (1.7: 1), (1.8: 1), (1.9: 1) with variations in vane classifier openings of 40%, 45%, 50%, 55%, 60%. From this experimental study, it is known that in certain coal characteristics, the setting followed by the vane classifier setting affects the quality of the 200-mesh pulverized coal. Experimental data can be observed feeding Berau coal which has the characteristics of Subbituminous coal with total moisture of 21.42% Wt and HGI 50, in the coal pulverizer unit 6 will produce 200 mesh fineness production and also has an impact on controlling metal temperature at the secondary superheater at level 564, 59° C below the operational limit if the MAFR setting is (1.8: 1) with an open classifier of 45%.

Keywords: *pulverizer, fineness, mill air fuel ratio, classifier, metal temperature, secondary superheater*

Numerical Study of Dual Fuel Engine using Proportional Natural Gas Split Injection

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Abstract. The progress of the improvement of dual-fuel diesel engines with diesel and natural gas (NG) fuel is quite significant. One of them implemented the split injection strategy. This study analyzed the effects of NG split injection on the combustion of modified dual-fuel diesel engines. The study was carried out numerically at 2000 rpm at low to high loads. Results from NG split injection were compared with single injection NG on different injection timings. The results show that NG split injection has a significant effect on high loads. NG split injection gives a slight decrease in combustion heat release even though the peak cylinder pressure increases at high loads. Thus, fuel consumption, CO emissions, and HC emissions increase. However, NOx emissions decreased. Nevertheless, NG split injection hardly affects the amount of torque produced.

Keywords: *natural gas, dual fuel, combustion, emission, split injection*

Investigation of Dual Fuel Engine Performance Based on Proportional CNG Substitution

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Abstract. In this paper the dual fuel engine is a standard diesel engine that is added other fuels at the air input and fuel ignition is done when the diesel fuel is sprayed into the combustion chamber. This paper aim is to investigate the dual fuel engine performance based on proportional compressed natural gas (CNG) substitution. In this experiment is use CNG as the substitution fuel. This experiment taking data from conventional diesel engine and dual fuel diesel engine with same CNG fuel substitution. Fuel substitution is how much is use fuel of the fuel to make power. In this experiment the fuel substitution of CNG keep constant about 45-50%. To get same fuel substitution is control the pulse width of the CNG injector. In this research, it is found that the proportional substitution of energy of dual fuel engine is not significant effect on power and torque of the engine. But proportional substitution on dual fuel diesel engine is has higher effect on SFOC of the engine.

Keywords: *standard diesel engine, dual fuel diesel engine, substitution*

Effect of B20 Heating on the Macroscopic Fuel Spray Characteristic

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Abstract. Biodiesel is a fuel made from plants or animals. The higher viscosity of biodiesel has received much attention from various researchers around the world to be developed. The impact of higher viscosity is the reduced quality of the injection spray produced. The purpose of this study was to determine the effect of heating on spray characteristics. The fuel used in this study is biodiesel 20% (B20). The method used in this study is by heating the fuel using a heater and testing the spray using an injector tester then recording it using a 240 FPS speed camera. Experimental data shows that the heating effect affects the penetration length, at 65oC spray length 49.1 cm, 6.6 cm shorter than ambient temperature. This is also in line with the average spray velocity which has decreased by about 0.6 m/s at 65oC compared to the ambient temperature. While the spray angle changes, at 65oC the spraying angle reaches 22.1, 2.6o wider than the ambient temperature.

Keywords: *biodiesel, spray characteristic, spray cone angle, spray penetration*

An Experimental Investigation of Natural Gas Injection Timing on Dual-Fuel Engine

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Abstract. The use of Natural Gas (NG) in internal combustion engines has been increased in this decade. The objective of this paper is to investigate the NG injection timing on dual fuel engine. In this paper experimental based on dual fuel engine strategy (DFE strategy) was tested with several variations of gas injection based on CA at the modified direct injection engine into a DFE strategy. In the data test the variation is CA 160, 130, 100, 70 bTDC. This research is for observed how it affects engine performance. The indication of the effect of NG injection based on the CA variation is the non-homogenization of the NG-air mixture in the intake manifold, and the delay in mixing NG-air to go into the combustion chamber. From several data tests that have been done, there is an increase in engine power, BMEP, thermal efficiency and a decrease in SFOC fuel consumption.

Keywords: *diesel, dual fuel, injection timing, natural gas, performance*

Numerical Study of a Savonius Wind Turbine with Standard Blades and Bach Blades Variations

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Abstract. Numerical analysis is performed on Savonius turbine rotor with standard blades and Bach-profile blades. The standard configuration was taken as a half semi-circular cylinder with overlap. Savonius turbine with overlap blades is considered because it gives better performance compared to that without overlap. Meanwhile, the Bach-profile blades tested are varied with arc surface angles of 1240 and 1350. The objective of the study is to further comparing the performance of the Savonius turbine with standard blades with overlap to that with Bach-profile blades, particularly at very low wind speed. Steady, two-dimensional numerical simulations were performed on Savonius rotor turbine with standard blades and Bach-profile blades. Reynolds-Averaged Navier - Stokes solver was used to solve the computation, with the turbulence model of the transition k-kl-ω model. The simulations were run at constant freestream velocities of 4 m/s and 7 m/s, and at various rotor angle position. Overall, the results shows that the rotor with Bach-profile blades has higher static torque coefficient compared to that with standard blades with overlap. The self-starting capabilities are approximately similar for all the blade type tested.

Keywords: *savonius turbine, bach turbine, torque coefficient, numerical*

Performances of Three Solar Distillators with Different Absorbers

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Abstract. The need for clean water is the right of every living thing, especially humans. However, in the dry seasons, the fulfillment of the clean water in several regions in Indonesia is difficult. For that reason, this study examined simple tools to produce clean water. The study was conducted using three identical distillators with three different absorbers. The dimension of each distillator was 0.8 m x 1 m x 0.5 m, while the area of the each absorber was 0.8 m x 1 m or 0.8 m². The distillators had been tested for 3 days, from 9 to 16 Middle Indonesia Time. The material used was seawater. The seawater was evaporated and condensed in the distillator. The result of the condensation was clean water (distilled water). The absorber with fins produced the largest amount of distilled water. It is recommended to be used and developed in the future.

Keywords: *distillator, absorber, distilled water*

Effect of Natural Gas Injection Pulse Width on Dual Fuel Engine Performance

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Abstract. Dual fuel (natural gas -diesel oil) is one of the interesting strategies that can be applied to diesel engines related to emission reduction. On the other hand its application causes a decrease in diesel engine performance. So it is necessary to look for system settings that can produce the best performance. One possible setting to analyze is the NG injection pulse width. The aim of this paper is to investigate the effect of NG injection pulse. In this paper a variation of NG injection pulse width (PW) was carried out to determine the effect on the engine performance at low to high loads. From the experimental results, it can be seen that the variation of gas injection pulse width does not significantly affect torque, power, and BMEP. There is an increase by reducing PW up to 9 ms in medium and high loads but the changes are small. Variation of PW 11 ms has the lowest SFOC and the highest thermal efficiency at medium to high loads. While the biggest substitution is obtained by PW 12 ms but at 75% load, the substitution is lower than PW 11ms.

Keywords: *natural gas, injection pulse width, dual fuel, engine performance*

Investigation the Effect of Superficial Velocity to the Heat Transfer in Bubbling Regime of Fluidization Using CFD Simulation

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Abstract. Superficial velocity is one of the most important parameter that influences the fluidization quality. CFD simulation method and Factorial Design of Experiment have been used to investigate in inferential way, the significantly effect of superficial velocity to heat transfer in bubbling regime of fluidized bed. This research has been conducted with several superficial velocity of 0.35 m/s, 0.45 m/s, 0.5 m/s, 0.7 m/s and at several temperature variations of 150ºC, 200 ºC, 250 ºC, and 300 ºC. The results show temperature, velocity, and interaction between velocity and temperature affect coefficient of convection, which velocity is the most significant factor.

Keywords: *CFD-simulation, convection, fluidized-bed, superficial-velocity, temperature*

Numerical Investigation of Flow Through Square Duct with Installed Tripping Rod on square Elbow

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Abstract. This paper present result of a numerically investigation of air flow through a square duct with installed tripping rod. A square section duct with hydraulic diameter 125 mm was built for this study. This duct is consist of rectangular elbow with ratio of radius and hydraulic diameter is three. Tripping rods that is installed on rectangular elbow has three variation of shapes. The shapes are circular cylinder, square cylinder and oriented square cylinder, respectively . all tripping rods has constant dimension by circular cylinder diameter. Tripping rods are located near inner wall of rectangular elbow with constant gap ratio (g/d) 0,2. Variation of angular position are 4°, 5°, and 8°, respectively. Turbulent viscous models to run the simulation use k-epsilon standard with enhanced wall treatment. All simulation are modeled for Re 1,59 x 10^4 based on hydraulic diameter of duct. Numerical simulation result is consist of turbulent intensity , streamline and pressure drop. There is degradation of downstream pressure drop based on result if the circular cylinder used as the comparison point. oriented square cylinder has 2,3 percent degradation at downstream. square cylinder has 1,4 percent degradation at downstream at 4°.

Keywords: *square duct, rectangular elbow, circular cylinder, square cylinder, oriented square cylinder, tripping rods, turbulent, downstream, pressure drop*

Emission Analysis of Dual Fuel Marine Engine Using Multi Diameters Hole Injector Based on Simulation

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Abstract. This research is to reduce emission on dual fuel marine engine with compressed natural gas (CNG) and diesel fuel. One of this research is modify the diameters of the gas injector holes, that called multi diameter hole injector. This study analysis of emissions on dual fuel engines using multi-diameter holes injectors. Emissions analyzed were Nitrogen oxide (NOx), Carbon monoxide (CO) on simulation GT-Power. From the result shown that injector multi diameters hole with size 1mm can produce the lowest emission in brake specific NOx and CO.

Keywords: *dual fuel diesel engine, emission, gas injector, injector multi diameters hole*

Numerical Analysis of Dual Fuel Marine Engine Performance using Multi Diameter Hole Injector

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Abstract. The development of alternative fuels is increasingly being carried out by various parties as a solution to the increasing use of fuel. The proposed alternative fuel is a dual fuel system, better known as a Dual Fuel Engine. This paper has been carried out multi-diameter hole injector analysis on the performance of dual fuel diesel engine base on simulation. The engine used is the Marine Engine Yanmar TF 85 MH. The process of collecting data is analyzed using GT-Power software 7.4. The performance has been analyzed is the power, torque and SFOC. Based on the investigation, the multi diameter hole injector has been increase the engine performance.

Keywords: *diameter hole, dual fuel, injection, GT power, performance*

The Interactions of I-65^0 Type Cylinder and Savonius Wind Turbine for Performance Improvement

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Abstract. In this study, a cylinder cut at 65^0 degrees of both sides has been placed in front of returning blade Savonius wind turbine. This type of cylinder is called I-65^0 and its designed to reduce the negative torque on returning blade aerodynamically. The performance of wind turbine was investigated experimentally within two conditions, with and without installation of I-65^0 type cylinder. The experiments are conducted with Reynolds number of 167.000 based on free stream (U) 9 m/s and the length characteristic of d = 2D-e. The center point of I-65^0 type cylinder in which 0.5D in diameter is placed at 1.4D upstream returning blade for minimum. The experimental investigation show that the installation of I-65^0 type cylinder upstream returning blade improve the performance of Savonius wind turbine without I-65^0 type cylinder. In this case the maximum of Power Coefficient Savonius wind turbine with installation of I-65^0 type cylinder increase up to 19.64% and this is obtained at tips-speed ratio (TSR) 0.59. Numerical analysis performed for both Savonius wind turbine configuration using ANSYS Fluent program and the results shows that both analysis agreed each other.

Keywords: *I-65° type cylinder, savonius wind turbine performance, upstream of returning blade*

Numerical Study of Coal Combustion Characteristics of In-Furnace Blending Method with Variety of Feeder Coal Type at Tilting Burner Angle -10 ° of 625 MW Forced Circulation Boiler

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Abstract. The percentage of the coal-fired power plant in Indonesia is still dominant. Types of boilers used include boiler stockers, circulating fluidized bed boilers, and pulverized boilers. Based on the coal combustion burner layer, the pulverized boiler uses a front-rear and tangentially fired boiler type. The results of tangentially fired boilers are more perfect because the flow of turbulence is produced. Properties of coal also affect the level of perfection of the combustion process that occurs and the heat distribution in the boiler. The boiler initial design of Suralaya-8 Coal Fired Steam Power Plant that uses LRC will operate all boiler support equipment at full load, this will reduce boiler reliability. To improve the reliability of the boiler, it will be studied with LRC mixed with MRC which has a higher quality and calorific value so that at full load will reduce the load of boiler support equipment. So from that research is needed regarding the combination pattern and the entry of LRC and MRC coal at the proper burner elevation to produce more perfect combustion, there is no change in temperature distribution in the boiler, low unburn carbon without neglect the economical aspect of the plant operation. This numerical study uses the Computational Fluid Dynamics (CFD) method. Making boiler geometry using Gambit 2.4.6 software and numerical simulation using ANSYS Fluent 16.0. The simulation includes the standard turbulence k-ε model. The material uses LRC and MRC with the provision of MRC inclusion at the bottom burner and LRC elevation above with a -10 ° tilting burner angle. Boundary condition uses the inlet velocity for primary and secondary air nozzle, CCOFA, and SOFA. Coal injection as mass flow inlet. The outlet parameter is a pressure outlet, a heat exchanger as a porous medium that has a heat generation. Waterwall tubes as walls that have heat fluxes. The result of this study will show simulation results and analyze changes in heat distribution in boilers to boiler performance, exhaust emissions and economic studies of mixing MRC in LRC with variations in the inclusion of MRC at 1, 2 and 3 burner layer coal.

Keywords: *the boiler, coal combustion, CFD*

Prediction of furnace cleanliness status with artificial Intelligent for sootblower advisor in PLTU Suralaya Unit 4

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Abstract. In the boiler system of PLTU (steam power plant), Sootblower plays an important role in maintaining the cleanliness of the surface of the boiler pipes for heat absorption in the boiler pipes are more effective. Sootblower is a device cleaning slagging and fouling attached to the boiler pipes that are formed due to burning coal in the boiler. The result of burning coal in addition to producing bottom ash and fly ash will also cause slagging and fouling which will reduce the efficiency of the boiler. To get to intelligent sootblower is needed a few steps to achieve it, so that in this research will be done the first step to start the system, namely by predicting the status of cleanliness in the furnace boiler Using the artificial intelligent neuro-fuzzy ANFIS by using the Matlab software. ANFIS have been widely used to make a prediction of a system that facilitates decision-making. The expected outcome on this study was to get the predicted results to be used as a Sootblower operating advisory system.

Keywords: *sootblower, neuro-fuzzy ANFIS, sootblower advisory system*

Ratchet Flywheel Regenerative System to Enhance Energy Captured for Electric Vehicle (EV)

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Abstract. Regenerative Braking System (RBS) converts kinetic energy into electrical energy by using a motor and functions as a generator when decelerations occur. Regenerative braking is an effective alternative to increase the driving range of a vehicle and can save around 8% - 25% of the total energy used by a vehicle. The purpose of this research is to produce a design of the Ratchet Flywheel Regenerative System and its system topology. The design of this system is to optimize the download of vehicle kinetic energy based on the duration of energy transfer that occurs. This study focuses on the flywheel energy download system and is done by numerical simulation using MATLAB software. The method to be designed is to apply of ratchet flywheel topologies

Keywords: r*egenerative braking system (RBS), ratchet, flywheel regenerative, topology*

Force Coefficients Characteristic on a Four Circular Cylinders in an In-Line Square Configuration near a Plane Wall at "Small Gap"

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Abstract. The force coefficients on a four circular cylinders in equispaced arrangement located near a plane wall were calculated from the pressure distributions. The pressure distributions on the each cylinder surface and on the plane wall were measured for various a spacing ratio value of L/D= 2.0, 2.7, 3.0 and 4.0 (L, center to center spacing between cylinders; D, diameter) and G/D= 0.2 (G, gap spacing between cylinder surface and the plane wall) in a uniform flow at a Reynolds Number of 5.3 x 104. The results show that the drag and lift coefficients on the cylinders depend on the spacing ratio value of L/D. The drag coefficient is decreasing, when the value of L/D is increasing especially on the upstream cylinders. The lift coefficient on the upper-downstream cylinders have a biggest value more than others cylinder at a small spacing ratio.

Keywords: *force coefficient, four circular cylinders, plane wall*

Optimization of CNG Injection Duration on Combustions and Emissions Characteristics on CNG-CPO Biodiesel Dual Fuel Engine with Load Variations

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Abstract. The number of CNG substitution on dual fuel engine affects engine performances and emissions. Thermal efficiency and air fuel ratio (AFR) decreased significantly with the addition of CNG quantity, and also increased emissions of carbon monoxide and hydrocarbon. The injection duration acts as a controller for the amount of CNG injected into the cylinder, so that the right injection duration is needed to get better engine performances and emissions, taking into account the percentage of CNG substitution. The study was carried out experimentally on a dual fuel CNG-CPO biodiesel engine by varying the duration of CNG injection from 70-150 degree CA with 20 degree intervals on all engine loads (low, medium, and high. The results showed that the injection duration of 70 degree CA was more optimally used under lower load, and in the medium load obtained the injection duration of 90 degree CA, and the duration of injection of 110 degree CA was more appropriately used under high load, this was evidenced by increased combustion performances and emissions are better than other variations.

Keywords: *dual fuel CNG-CPO biodiesel engine, the duration of CNG injection, combustion performances, emissions*

Combustion and Emissions Characteristics on Stationary Diesel Engine With 30% Water in Diesel Emulsion Fuel

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Abstract. This study uses an emulsion fuel with a mixture of 30% water and 70% diesel on a Diamond DI 800 stationary diesel engine with an engine speed of 1500 rpm. This research varied injection times from 13oCA BTDC to 19oCA BTDC at intervals of 2oCA. At each injection time variation, the engine load used is 1000W, 2500W, and 4000W. The results showed that advancing injection timing can shorten the ignition delay and the duration of combustion at all loads. The results of the variation in injection time at cylinder pressure and the heat release rate rise along with advancing injection time and optimally at 17oCA BTDC then drop back. Increase in-cylinder pressure and heat release rate at high loads when compared to standard conditions of 4% and 16.7% (respectively). HC and CO emissions decrease with increasing engine load. Smoke emissions increase with increasing engine load. the optimal value of emissions is at an injection time of 17oCA BTDC.

Keywords: w*ater in diesel emulsion, injection timing, emissions, diesel engine, combustion characteristics*

Site Investigation on Water Cooled Chiller Plant for Energy Conservation and Environmental Impact Reduction of a Large Shopping Mall

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Abstract. The investigated shopping mall building comprises indoor shopping, entertainment, and food centers which are simultaneously open from 10 a.m. to 10 p.m. The building is conditioned from a central plant incorporated water cooled chiller system comprises three identical chillers of 1245 tons of refrigeration (TR) cooling capacity per chiller. This paper is aimed to evaluate energy and environmental performances of water cooled chiller plant and develop energy conservation and environmental impact reduction strategies to the building. Chillers' operational data were hourly recorded which include power consumption, condensing and evaporating temperatures, evaporator-condenser approach temperature, ambient temperature and flowrate of chilled and cooling water. Annual data of chiller operation were recorded. Chillers' energy performance, indirect environmental impact and main factors that influenced the chiller plant performance were hourly and daily evaluated. The results showed that the chiller could steadily operate all year round with load factor ranging from 72%-100% and annual average load factor of 86%. Annual energy consumption of the chiller plant was 6,654 MWh accounted for 26.4% of total energy use and environmental impact due to energy consumption was 4,755 tons CO2. Annual Coefficient of Performance (COP) and power efficiency of the chiller were 5.67 and 0.62 kW.TR-1 respectively. The results also showed that energy consumption and environmental impact of the chillers were sensitive to load factor and approach temperatures of the condenser. Chillers with lower load factor and lower condenser approach temperatures could perform better. Monitoring and keeping load factor from 72% to 80% and approach temperatures of the chillers below 1.5 K for condenser were found to be potential strategies for energy efficiency and CO2 emissions reduction of the building.

Keywords: *mall, energy performance, environmental impact, water cooled chiller, approach temperature*

Analysis of Particulate Dispersion from Coal Use in Suralaya Coal-fired Power Plant

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Abstract. Suralaya Coal-fired Power Plant (CPP) not only produces electricity but also exhaust emissions, consisting of particulates. Regulations regarding the emission quality standards for particulates are about total particulates, while for ambient air quality include TSP, PM10 and PM2.5. Coal quality is one of the dominant factors in producing particulate emissions not solely the performance of emission control devices, namely Electrostatic Precipitator. The research method was carried out by secondary data collection related to coal, chimney characteristics, study area maps and meteorological data, data analysis and modeling using AERMOD which was also supported by Aermat, and data validation based on direct measurements at the monitoring point manually using portable analyzer. The research radius was made 15 km considering the sensitive areas of dispersion such as settlements, ports and other public spaces with a monitoring grid of 30 x 30 from the midpoint of the source of emissions. The receptor is adjusted to the monitoring point at the Suralaya CPP. From the initial results of the dispersion that has been done before, the highest distribution level is in a radius of 1-6 km.

Keywords: *coal, particulates, dispersion, AERMOD*

Experimental Study The Effect of Excess Air in to Unburn Carbon and Boiler Efficiency Using Coal with Heating Value 4200 kcal/kg at a 500 MW Capacity Power Plant

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Abstract. Boiler is one of power plant equipment that have function to produce steam. Thermal boiler efficiency is defined as the incoming heat energy that is used effectively to produce steam. There are two methods for evaluating boiler efficiency, namely direct method (input output method) and indirect method (Heat Loss). The experimental method carried out in this study was to conduct experiments and retrieve data on steam power plant boilers with a capacity of 500 MW with LRC coal with a calorific value of 4200 kcal/kg with variations in the ultimate levels of coal. The results of the data were then analyzed to see the effect of variation excess air into unburn carbon and boiler efficiency that evaluated using indirect methode. The excess air versus unburn carbon and boiler efficiency curve is using for determining of optimum percentage of excess air.

Keywords: *efisiensi thermal, boiler, excess air, unburned carbon, coal fineness*

The Effects of Pilot Injection Timing in Dual-Fuel Diesel Engine using Biodiesel-CNG on The Combustion Characteristics and Exhaust Emissions

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Abstract. Biodiesel and compressed natural gas (CNG) are alternative fuels that can be used in a dual-fuel diesel engine. In this study, Biodiesel was used as a combustion pilot which injected directly into the combustion chamber, and CNG was used as a substitution fuel. CNG was injected into the intake manifold and controlled by an electronic control unit (ECU). The pilot injection timing has an important role in controlling the initial combustion process in dual-fuel diesel engine. The engine was operated at constant speed of 1500 rpm and was given low and high load. The pilot injection timing in dual-fuel diesel engine was varied from -11° to -19° in steps of -2° crank angle (CA) after top dead center (ATDC) to investigate the combustion characteristics and exhaust emissions. The results show that, with advanced pilot injection timing, cylinder pressure and heat release rate (HRR) increase by 20.4% and 13.1% respectively at low load. Moreover, cylinder pressure increase by 12.5 % but heat release rate (HRR) decrease by 25% at high load. For the lower exhaust emissions, can be achieved with advanced pilot injection timing -17° CA ATDC at all test conditions.

Keywords: *pilot injection timing, diesel dual fuel, biodiesel-CNG, combustion characteristics, exhaust emissions*

Numerical Study Effect of Burner Tilt Angle on the Boiler Rear Pass Temperature on PLTU Banten 1 Suralaya under LRC and MRC Coal Conditions

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Abstract. Coal, as the main fuel of boiler, has a very significant effect on combustion characteristics and heat absorption in the boiler. Variations in coal specifications require regulation of boiler operating parameters to improve combustion efficiency and prevent failure of boiler tubes. The purpose of this study is to validate the simulation model on CFD software for 1x625 MWe capacity boiler according to the performance test parameters data. This simulation model, then, used to find out the temperature data on the rear pass boiler area and the temperature deviation between the left and right sides boiler. Then, the simulation output data compared with a measured operating parameter using statistical hypothesis testing methods. This study expectation is the difference between the simulation results and measured operating data is not significant. The simulation model can be used to obtain the right and left temperature deviation values and the rear pass temperature with different burner tilt angle and input coal calorific value in the further study then.

Keywords: *CFD, boiler, burner tilt angle, rear pass temperature, validation*

Numerical Simulation Of Coal Particle Size (Fineness) Effect to Combustion Characteristics of Sub-Critical Pulverized Coal Boiler 600 MW Capacity

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Abstract. The use of coal with a lower quality than the coal design resulting in the un-optimation of the combustion process so that it will affect the unit performance or efficiency. Coal quality problems are not solely from the calorific value parameter but also on Hardgroove Grindability Index (HGI), this HGI value will affect to coal particle size (fineness) that goes into the furnace. Some of the impacts of the particle size bigger than standard size are the more unburn carbon, increasing the slagging fouling potential, and increasing the residence time of coal that will affect the furnace exit gas temperature is higher. Simulation with CFD is an effective and efficient solution to determine the effect of fineness on the boiler combustion characteristics. In modeling the gas phase combustion process, a mixed fraction approach is used with the probability density function (PDF) method. The input and boundary condition data are determined based on data collected when operating 600 MWe and for calculating coal particle size distribution using Rosin-Rammler law. The simulation is carried out by varying the three sizes of fineness, namely those that pass the 200 mesh sieve with 70%, 60% and 50%. The results obtained in the form of temperature and velocity distribution of combustion products to find out in any area in the boiler that potentially high level of erosion and where intensive particle deposition can occur, and to show the impact of particle size on un-burned carbon (UBC).

***Keywords**: pulverized coal combustion, HGI, coal fineness, computational fluid dynamic (CFD), probability density function*

The Effect of Compression Ratio Variations to Engine Performance and Emissions Characteristics on Diesel Engine Fuelled With Ethanol-Intermediate Sulphur Content Diesel Fuel (Dexalite) Blend

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Abstract. Most heavy mover, Powerplant, and Industrial sector in Indonesia use fossil fuel as its main energy resources. Unsustainable and about to be depleted in the near decades was the main reason of which a substitution is necessary for fossil fuel. Bioethanol one of several alternative energy that environmentally friendly and easy-to-produce was a proper replacement for fossil fuel. This paper illustrates the result for the performance and emission of Dexlite-Ethanol blend using Diesel engine in varies compression ratio (16:1, 17:1, 17.9:1). Tests were performed with five different blends of ethanol (Dex50, Dex60, Dex70, Dex80, Dex90). 10% of tween 80 (emulsifier) added to the blend to prevent phase separation and maintain homogeneity of the blends. Before testing using the compression ratio variations, Dex70 and Dex80 appear to has the least content of CO, UHC and Smoke Opacity in a compression ratio of 17.9 (standard). Then the result from variated compression ratio is; for Dex80, Brake thermal efficiency, Air-Fuel Ratio and Smoke opacity increased gradually by 25,6%, 8% and 44%; for Dex70, Brake thermal efficiency, Air-Fuel Ratio, Smoke opacity, and UHC rose by 24,2%, 15,9%, 4,7% and 66,7% compared to neat diesel (Dexlite).

Keywords: *dexalite, ethanol, compression ratio, performance, emission.*

Modeling and Simulation of Engine Speed on Idle Speed Conditions System by using MIMO on Spark Ignition Engine

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Abstract. Multi-Input Multi-Output (MIMO) system formed without compensator and prefilter is a modeling of Spark Ignition Engine (SIE). This system in the form of engine stand that is gasoline fuel, motor speed or engine speed is strongly influenced by throttle valve, spark advanced position and load changes in SIE. The MIMO system model connects engine speed and manifold pressure to two system inputs, namely Duty Cycle of the throttle valve D(s) and spark advanced position A(s). The operation of the SIE is divided into three conditions: engine speed for idle speed without load conditions, engine speed for idle speed low load conditions and engine speed for idle speed conditions with gear-1 loading. This process is reviewed for each of the three MIMO SIE system conditions by inputting random data from the duty cycle of the throttle valve D(s) and spark advanced position A(s). Response of engine speed N(s) and manifold pressure P(s) are obtained by using Matlab simulation for input D(s) = 120 to 260 and for A(s) = 0.2 rad up to 0.5 rad. The simulated results show the response graph of the P(s) manifold pressure for the SIE MIMO system is always changing.

Keywords: *MIMO system, speed engine, idle speed, duty cycle of the throttle valve, spark advanced position, manifold absolute pressure.*

Effect of 35% Water in Diesel Emulsion Fuel and AFR Enriched Combustion on the Combustion And Emissions Characteristics

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Abstract. This study uses an emulsion fuel with a mixture of 35% water and 65% diesel on a Diamond DI 800 diesel engine with engine speed constant 1500 rpm. This study will be varied AFR 0,013 kg/s, 0,018 kg/s, 0,023 kg/s, 0.028 kg/s and variations in engine load starting from 1000 W, 2500 W, and 4000 W (respectively). The results of the emulsion study will be compared to diesel fuel under standard engine conditions. The results showed that enriched AFR can shorten the ignition delay and the duration of combustion at all loads. The use of a 35% emulsion increases almost all cylinder pressure peaks. The trend shows that the use of emulsion fuels tends to increase HC and CO emissions along with the increase in water content in emulsion fuels but reduce smoke emissions.

Keywords: *water in diesel emulsion, injection timing, emissions, diesel engine, combustion characteristics*

Development and Experimental Evaluation of Small Concentrated Solar Oven

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Abstract. In this work, the small scale of solar oven was developed and its performance was evaluated. The dimension of oven was 13.5 x 13.5 x13.5 cm of length, width, and height respectively. To concentrate the incident radiation, four flat reflectors were installed and the reflected radiation were directed to the oven. The artificial solar radiation which consisted nine incandescent light bulbs in array was used as source of radiation for performance evaluation. 90 grams of water was used as tested material to be heated. The temperature of water, oven chamber, and ambient were measured by using thermocouples and the radiation intensity was measured by using solar power meter. Four configurations of solar oven were compared to investigate the influence of glass cover on the top of oven and insulation layer on the wall of oven under various intensity of radiation. The experimental results show the highest temperature was achieved when glass cover and insulation layer were installed at the oven. In this configuration, the increase water temperature was observed as 7.6 ℃ and 26.6 ℃ under radiation intensity of 137 and 880 W/m2 respectively. However, the efficiency of oven tended to decrease when the radiation intensity was high

Keywords: *solar oven, solar thermal energy, efficiency*

Passive Flow Control on Square Duct and 90° Elbow with Circular Turbulator at Certain Gaps

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Abstract. The ducting system has considerable energy losses in channeling cold air in a high building. At the square duct and 90° elbow, the pressure drop due to friction loss, separation loss, and secondary flow. An increase in pressure drop can increase the amount of energy consumption needed. The method identified in reducing this energy loss is by using passive flow control. This study aims to identify the characteristics of the fluid in the ducting with variations in the circular turbulator gap. The variation of the gap between circular turbulator and 90° inner elbows (g/Dh) is 0.01 - 0.05. The ducting model used is a square duct with a hydraulic diameter of 125 mm. Ducting consists of 7Dh upstream duct, Circular turbulator (CT) with a diameter of 12.5 mm, 90° elbow with a curvature ratio (Rc/Dh) of 1.5 and a downstream duct of 15Dh. Tests are carried out at ReDh= 3.97x104, 8.74x104, and 13.5x104 or velocity of 5 m/s to 17 m/s with an increase in velocity of 1 m/s. The results showed that the addition of circular turbulator g/Dh = 0.02 reduced the pressure drop by 20.52%. While g/Dh = 0.04 and 0.05 can increase pressure drop. The addition of CT can form a shear layer that has a higher turbulence intensity (TI) so that it can fight advers pressure or delay flow separation due to 90° inner elbow curvature. The use of CT with g/Dh = 0.02 can increase TI by 30.92% at y/Dh= -0.444. While the ducting without CT only produces turbulence intensity of 18.02% at y/Dh= -0.444. When compared with ducting without ct, the use of ct with g/Dh= 0.01, 0.03, 0.04 and 0.05 at y/Dh= -0.444 found a decrease in turbulence intensity of 13.17%, 15.95%, 15.89% and 8.51% respectively

Keywords: *pressure drop, circular turbulator, gap, square elbow, turbulent intensity*

Numerical Study on the Performance and Flow Field of Varied Conical Basin for Efficient Gravitational Water Vortex Power Plant

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Abstract. Nowadays, utilization of hydropower is still focussed on the development of large dams which have an effect on the natural environment and are often opposed by the people in the region. Producing electricity from small water resources, especially using the gravitational vortex method has currently attracted the interest of researchers. In this paper, a numerical study of the effect of vortex pool variation on the performance and flow field of gravitational water vortex power plant (GWVPP) are investigated. Numerical study based on the volume of fluid (VOF) method is developed in ANSYS FLUENT code program for analyzing the parametric studies of GWVPP. Cylindrical vortex pool coupled with gravitation type water turbine based on Nishi and Inagaki (2017) research, are modified become conical vortex pool type by varying the ratio of inlet diameter and outlet diameter (Din/Dout) by 3.26; 4.9; and 9.8. Turbulent model is approached using SST (shear stress transport)- kω and boundary conditions are set 2.838 kg/s for inlet mass flow rate, 0 Pa for open and outlet boundary, and rotational velocity varied from 81 rpm, 122 rpm, and 162 rpm. As a beginning result, the computational values of this study and experimental data of the torque and turbine output from Nishi and Inagaki (2017) agreed with one another. Later, It can be seen from velocity contours, the maximum velocity measured for the conical basin was higher than cylindrical basin for the nearly similar condition of head and discharge geometry. Furthermore, for conical basin with the variation of Din/Dout ratio, it can be shown that the maximum velocity profile achieved in nearly to the discharge hole, in order from 9.8; 4.9; followed by 3.26 of the Din/Dout ratio respectively. This can be explained with fluid mass conservation of steady flow as with the decrease of flow area in the basin, the velocity will increase thereby maintaining the constant flow rate

Keywords: *free-surface, open channel, volume of fluid, water vortex*

Design Evaluation of an Automotive Radiator for Student Formula SAE Vehicle "Bimasakti": Thermal Calculations

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Abstract. Bimasakti is a single-seater formula vehicle manufactured by UGM students which compete annually in the Japan Student Formula SAE Competition. To prevent engine overheating, a proper design of radiator should be considered to prevent heat dissipated produced by the engine and maintain the optimal engine temperature. In this study, an evaluation towards 2 radiator designs (radiator A and B) was conducted in term of thermal calculation. Water was used as a working fluid inside the radiator. This vehicle used a KTM 450 SX-F engine (450 cc) as the prime mover with maximum power of 44 kW. In this study, it was assumed that 7.33 kW of heat should be exchanged by the radiator with assumption of 0.25 effectiveness. The coolant temperature from the engine was assumed to be 95°C. As the result, the radiator B with the total heat transfer area of 2.86 m2 could dissipate the heat of 9.16 kW which was better than radiator type A. Furthermore, the increase of coolant flow rate (in different engine speed) also improve the performance of a cooling system of radiator.

Keywords: *automotive radiator, thermal calculation, radiator design, design evaluation, student formula SAE*

Analysis of an Optimum Method for Power Generation Using Flare Gas from Oil Refinery Plants

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Abstract. These days the world is facing global warming as one of its biggest challenges. The main route cause of this ever-growing problem is the ever increase greenhouse and carbon dioxide concentrations in the atmosphere. Gas Flaring is one of the activities that is also contributing to the high levels of these gases. In 2018 a total of 145 billion cubic meters of natural gas was flared worldwide. Indonesia being an archipelago nations and located near the equator suffers greatly from these global warming impacts. The impacts include environmental degradation, health implications and economic effects. This study is intended to develop a power plant configuration that can be adopted at an already existing plant to use flare gas as a complementary fuel. The energy of the flare gas will be converted into mechanical energy through thermal power plant instead of being vented as presently. Two possible plant configurations were developed and simulated using Thermo-flow and the results were compared. Both configurations employ the combined cycle concept, where a gas turbine is coupled with a steam turbine. The main difference between the two configurations is that configuration 1 uses a Heat Recovery Steam Generator whilst the second configuration uses common Heat Exchangers in-between the gas turbine and the Rankine cycle. The results show that configuration 1 would generate a net power of 40.948MW whilst configuration 2 would generate 32.924MW.

Keywords: *flare gas, heat recovery steam generator, heat exchanger, thermo – flow, thermal power plant*

Numerical Study of Optimization Performance Induced Draft Fan Through Openings Setting the Inlet Guide Vane

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Abstract. Boilers are an important part of the Steam Power Plant. One of the combustion systems in the boiler is using the balance draft method, where combustion air conditions in the furnace supplied by Force Draft Fan (FDF), and residual combustion air (exhaust gas) are sucked with Induced Draft Fan (IDF) by maintaining the -30 Pa pressure furnace accordingly manufacturer's standard. Furnace has not been able to achieve ideal conditions, because the performance of Induce Draft Fan (IDF) has less optimal suction power. This is allegedly from the opening of the Vane Inlet Guide which is not yet optimal. The test model in the form of Induce Draft Fan is simulated using CFD modeling software. The dimensions of the inlet guide vane, rotor, and static blade are carried out by 3D scanning. While for the casing model uses the manufacturer's reference image. The results of this study are expected to improve IDF performance by determining the variation of the damper opening (IGV opening angle) optimally. From CFD simulation, pressure suction becomes more vacuum by opening the IGV from -10, 0, 10. The value of the IDF pressure suction is -10=-2334.94 Pa, 0=-3117.14 Pa, 10=-3321.90 Pa. Considering the process of setting the Inlet Guide Vane opening angle on the Induce Draft Fan requires a shutdown unit and production opportunities will disappear and the costs are relatively large, the performance optimization process is carried out using simulation.

Keywords: *inlet guide vane, induced draft fan, angle of attack, CFD*

Numerical Analysis of Conjugate Porous Media for Increasing Heat Transfer Rate in Fixed Bed Spheres

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Abstract. Porous media becomes a potential alternative for cooling technology since it has large contact surface area that strongly enhance heat transfer and exchanging energy within pore channel. A computational fluid dynamics of conjugate heat transfer and periodic boundary condition were applied in FLUENT 6.3.26. Simulations of fixed bed spheres as porous media inside pipe flow were carried out in the range of Reynolds number 5000 to 80000. Simulation methodology was validated by analytical prediction. In the range of Reynolds number 100 – 6000 is very good agreement, however in the range of Reynolds number above 6000 - 10000 just fairly agree. This is caused by the fact that in the range of Reynolds number above 6000 analytical model does not use turbulence model. Fluctuation effects are just considered as dispersion. The results shows that the fixed bed spheres for porous structure gives the highest value of the cooling effectiveness than the other porous structures except for ReD ≤ 10000, the cooling effectiveness of the discrete porous structure is higher compared to the analyzed fixed bed porous structures. At ReD =15,000 the fixed bed spheres gives 28%, 65% and 160% higher effectiveness compared to the discrete porous structure, 60◦ broken ribs and 90◦ continuous ribs, respectively.

Keywords: *CFD, conjugate heat transfer, fixwd bed, spheres*

Flow Structure Investigation Heat Transfer Enhancement on Inner Tubular Pipe with Winglet Vortex Generator

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Abstract. Vortices phenomenon appear become one of solution to enhance heat transfer performance in shell and tube type of heat exchanger. Vortex generator is a utilization that can generate moving vortices of fluid to get good mixing fluid in heat transfer. The aim of this study is to find the effect of rectangular and delta winglet vortex generator if it is applied in inner tubular pipe heat exchanger especially for shell and tube heat exchanger. Two types winglet vortex generators were mounted in inner circular pipe then examined in turbulent flow with 6000-10000 Reynold numbers. The result of simulation showed that the use of rectangular and delta winglet can improve heat transfer performance.

Keywords: *heat exchanger, vortex generator, CFD*

Material

Influence of Thermal Cycling of Cold Rolled Stainless Steel 316L onto Hardness and Microstructures

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Abstract. Investment casting of orthopedic broad plate implant based on stainless steel AISI 316L was considered an economical process as compared to other manufacturing processes. Nevertheless, the mechanical properties of the investment casting product were found to be lower as compared to implant produced using hot forging method. In order to improve their mechanical properties, the investment casting implant broad plate was cold-rolled up to 50% reduction in thickness and then thermally cycled to initiate recrystallization of the new grain of AISI 316L. These processes will increase the strength and hardness of the material without sacrificing ductility or toughness. It was found that thermal cycling treatment at a temperature of 950 C for 35 seconds within four cycles will aid recrystallization of the new grain of 22 µm in size as compared to investment casting grain size of 290 µm. The hardness also increases from 139 HV1 in investment casting product to 253 HV1 after thermal cycling. Lower thermal cycling temperature did not alter the microstructure indicating that no recrystallization happens during treatment and only residual stress relieve that was taking place.

Keywords: *316L, cold rolling, investment casting, thermal cycling*

3D Reconstruction of Rolling Contact Fatigue Cracks in Rails with Tight Serial Cutting

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Abstract. Rolling contact fatigue (RCF) crack is one of the crucial issues in rail condition monitoring. This type of crack is occurred in the rail and can be a threat that leads to a fatal accidence, such as rail breaking. In order to study this crack, effort on revealing its full structure has been an attentive topic. In term of destructive technique, computed tomographic (CT) technique and serial cutting are two common methods to study RCF crack structure. In this study, a tight serial cutting of a cracked spot from a used rail sample has been done. The rail sample was cut from Akeshov, Sweden. The rail was sliced into 0.65mm-thick identical pieces with 0.35-mm thick electrical discharge wire (EDM). From the sliced pieces, a 3D RCF crack image has been reconstructed. Due to tight slicing, the structure of crack can be observed clearly and thus its angle, depth, network, branches and profile can be analysed. This method seems promising to verify defect measurement with non-destructive technique, such as ultrasonic measurement and eddy current testing. Other mechanical characterisations can also be performed with this 3D image crack reconstruction.

Keywords: *3D image reconstruction, rolling contact fatigue crack, railyway, near – surface crack*

Friction and Wear Performance of Phosphonium-based Ionic Liquid Additives in Glycol Media

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Abstract. Ionic liquids (IL) have been widely discussed as potential lubricants, however, they can also be potential candidates as lubricant additives like friction modifiers (FM) and anti-wear (AW). In this study, three phosphonium-based IL candidates as FM and AW additives have been investigated: tributylmethylphosphonium dimethylphosphate (PP), trihexyltetradecylphosphonium bis(2,4,4-trimethylpentyl)phosphinate (PB), and trihexyltetradecylphosphonium decanoate (PC). Diethylene glycol (DEG) was used as the base lubricant. The effects of cation alkyl chain length and types of anion on tribological performance were investigated using unidirectional pin-on-disk tribometer under boundary conditions at room temperature and 75^{o}C. Dodecanoic acid (C12) was selected as a reference additive because it is a widely used friction modifier. From this study, C12 reduces both friction and wear rate in DEG media. PP which has a shorter alkyl chain in both cation and anion shows an increase in both friction and wear. On the other hand, longer alkyl chain IL like PB and PC, demonstrated effective friction modifier and anti-wear performance, where decanoate anion seems to give the lower coefficient of friction but higher wear rate compared to phosphinate anion.

Keywords: *diethylene glycol, phosphonium – based ionic liquid, boundary additives, friction, wear*

The Effect of Acidity and Rotation Speed in Titanium Dioxide Synthesize Process

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Abstract. The aims of this study are to analyze the effect of acidity and rotational speed in the synthesis of TiO^2 using the sol-gel method and to analyze the morphology of synthesized TiO_2 nanoparticles and commercial TiO_2 using XRD to produce semiconductors for Dye-Sensitized Solar Cell (DSSC) applications. The sol-gel method was used to synthesize TiO_2 Nanoparticles. Titanium tetra-isopropoxide (TTIP) was used as a precursor with the variable of the magnetic stirrer rotation speed of 500, 1000 and 1500 rpm. Acidification was achieved with adding acetic acid to Sol-gel solution to produce a pH number of 1, 2, and 3. Nanomaterial was observed with an optical microscope and X-ray Powder Diffraction (X-RD) to determine the morphology and phase of TiO_2 crystalline. The results showed that the rotational speed and acidity level of the Sol-gel solution ware played an important role to get the best form of a nanoparticle. At a rotation speed of 1500 rpm with pH 3 and 1000 rpm with pH 2 ware shown characteristics similar to commercial TiO_2. In addition to that, the results of XRD characterization of synthesized TiO_2 was shown a crystal phase of anatase structure with 18,046 nm crystal size compared to commercial TiO_2 with anatase structure and crystal size of 15,554 nm.

Keywords: *dye-sensitized solar cell, sol – gel, XRD*

Fabrication Membrane of Titanium Dioxide (TiO2) Blended Polyethersulfone (PES) and Polyvinilidene Fluoride (PVDF); Characterization, Mechanical Properties and Water Treatment

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Abstract. In this research, Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) with addition Titanium Dioxide (TiO_2) blended membranes are prepared using the DC 15000 V electric field method. Investigated of this research were effects of the addition of Titanium Dioxide (TiO_2) and DC electric field methods such as the mechanical properties of membranes and water treatment performance. The surface of Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) blend membrane obtain were characterized using SEM, The membrane pore size shrinks and forms evenly with the addition of Titanium Dioxide (TiO_2) and the DC electric field method. The tensile test was performed to obtain the mechanical properties of Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) with addition Titanium Dioxide (TiO_2) blend membrane, which showed an increase in the optimal tensile strength to 3.86 MPa at a concentration of 30% Polyethersulfone (PES) and also increased up to 1.15 MPa at 20% Polyvinylidene Fluoride (PVDF). The surface of the membrane was examined using contact angle measurements, which in the Polyethersulfone (PES) and Polyvinylidene Fluoride (PVDF) blend membranes showed a decrease angle between the range 43º - 46º. Therefore, hydrophilicity permits to suppress pure water permeate flux. The membranes fabrication with the addition of Titanium Dioxide (TiO_2) and assisted by the DC electric field opens up new ways to increase membrane strength, hydrophilicity, shrinks and makes formed evenly pore size.

Keywords: *polyethersulfone, polyvinylidene flouride, titanium dioxide, flat sheet, electric field*

An Experimental Investigation of Geopolymer Composite Reinforced by Short Carbon Fiber

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Abstract. Since its introduction in the 1970s, geopolymer composite technology has been progressing rapidly with various improvisations. But its use is still limited to building materials with additional sand and coral. This research presents the mechanical properties of geopolymer composites for other applications, such as pipes, by replacing sand and corals with carbon fiber. Geopolymers consist of fly ash, kaolin, silica fume and calcium oxide which are activated with sodium silicate. To increase the mechanical strength, 2 cm carbon fiber is added randomly with varying percentages. Experimental design and analysis were performed by Taguchi method to obtain 16 specimens with various compositions. Samples were tested by bending three-point test (ASTM C1161), XRF, SEM-EDX, and XRD. The test results showed that the 5 best samples were T8, T7, T16, T15, and T11. The best flexural strength is about 86 MPa and flexural modulus is 20 GPa with composition: FA 50%, K 40%, SF 10%, CaO 4% and carbon fiber 15%.

Keywords: *geopolymer, fly ash, carbon fiber, flexural strength, pipe*

Low Cycle Fatigue Properties of Aluminizing Coating on Cold-Drawn AISI 1018 Steel

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Abstract. The cold-drawn AISI 1018 steel (CDS 1018) was coated by hot-dipping aluminizing coating (HDA steel). The mechanical properties and the low cycle fatigue (LCF) properties of the CDS 1018 and HDA steel were investigated at room temperature. The aluminide coating on a CDS 1018 significantly decreases the mechanical properties and the strain-fatigue life of the material. By increasing in strain amplitude levels, CDS 1018 experienced a continuously cyclic softening behavior after a cyclic loading in few cycles. In contrast, the cyclic softening of HDA steel was observed in the first few cycles and continuously the HDA steel exhibits the stable cyclic behavior until failure. The aluminide coating on CDS 1018 results a higher optimization fatigue cycles than those of CDS 1018 without aluminide coating by a factor of 3.0.

Keywords: *cold drawn aisi 1018 steel, aluminizing coating, strain – fatigue life, cyclic softening, cyclic hardening*

The Performance of Carbide Waste as an Adsorbent to Reduce Spark Ignition Engine Emission

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Abstract. The utilization of waste as an adsorbent has been proposed as one approach to reduce emission from spark ignition engine. In order to improve the air quality due to the fuel combustion from SI engine the utilization of adsorbent in exhaust line could be a solution. For that purpose, carbide waste has been used which functions as adsorbent and was placed in the engine exhaust line. Three adsorbent casing in length were used they are 50, 100, and 150 mm. The results showed that improvements on engine emissions have been gained as a result of the utilization of carbide waste in the exhaust pipe compared to that of without treatment. An improvement of 57% and 50% on CO and HC respectively were obtained as a result of the utilization of carbide waste. Through surface morphology analysis it was clear that the emissions were adsorbed by the carbide surface. Therefore, the longer adsorbent casing the better emission results were obtained.

Keywords: *carbide waste, emissions, adsorbent, SI engine*

Application of Seeds from Psidium Guajava as Organic Inhibitor

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Abstract. Corrosion is the process of natural changes in the nature of a material due to the influence or reaction with the surrounding environment. One way to control it is by adding inhibitors. In this study, seeds from guava (Psidium Guajava) were used as organic inhibitors. The test material used is API 5L grade B steel. For corrosive media, a solution of 1 M H2SO4 is used. In experiments used variations in the concentration of extracts 0, 2, 3, 4, 5 and 6 ml. The results of the experiments showed a decrease in the corrosion rate of API 5L grade B when there were additional inhibitors. This is supported by the experimental results of Potentiodynamic Polarization. The rate of corrosion without the presence of an inhibitor shows 75,018 mmpy whereas in the presence of 2,8845 mmpy inhibitors. Based on the calculation, the inhibition efficiency is 96.155%. This is also indicated by the results of the testing of weight loss that has been done. The efficiency shown is 90.130%.

Keywords: *corrosion, inhibitor, psidium guajava, polarization, weight loss*

Effect of Ground Glass Particles on The Water Absorption and Tensile Properties of Epoxy

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Abstract. The paper presents the effect of ground glass (GG) particles on the water absorption and tensile properties of epoxy. The GG contents were 0, 5, 10 and 15% (by volume). The GG particles in the epoxy changed the water absorption behaviour from Fickian to non-Fickian. The GG particles also increased the equilibrium water uptake but decreased the diffusion rate. In dry condition, the GG particles decreased the tensile strength but increased the elastic modulus. In wet condition, the GG particles reduced the detrimental effect of water on the tensile properties at the content of 15%.

Keywords: *ground glass, epoxy, water absorption, infrared spectroscopy, electron microscopy, tensile properties*

Improving of Electric Voltage Response Based on Improving of Electrical Properties for Multiferroic Material of BiFeO3-BaTiO3 System

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Abstract. Synthesis of nanomultiferoic material with the active content of bismuth ferrite (BiFeO3) and barium titanate (BaTiO3) was carried out. It is considering that it was difficult to obtain single phase of BiFeO3 as a base material for multiferroic materials. It is expected that the addition of BaTiO3 on ceramic alloys consist of BiFeO3 and BaTiO3 can improve the electrical properties of the ceramics and finally it could improve the multiferroic properties of the material. Multiferroic properties could be seen from the appearance of an electric voltage response if the material is given the effect of an external magnetic field. The synthesis process uses the sol gel method which is a good method of producing nano-sized material. Synthesis of nanomultiferoic ceramic materials is carried out by varying the weight ratio of BaTiO3 and BiFeO3 of 2: 1, calcination temperature of 350 ° C for 4 hours, then sintering with temperature variations of 700 ° C; 750 ° C and 800 ° C for 2; 4; and 6 hours. Characterization was carried out using X Ray Diffraction (XRD) to confirm phase formation. The electrical properties test which produces a hysterical loop is carried out to determine the value of remanent, coercivity and electric polarization saturation. Particle size measurements were carried out using the Beckman Coulter DelsaTM Nano instrument. The multiferroic phenomena is known from the appearance of an electric voltage response if there is an effect of an external magnetic field on the material. The smallest particle size was obtained on ceramic powder which experienced sintered of 750oC. The best values of remanent, coercivity and electric polarization were obtained on ceramics which were sintered at temperatures of 750oC for 6 hours. This is linear with the highest value of electrical voltage arising as a result of the effect of the external magnetic field given to the ceramic material. Material that has a large electrical voltage response shows good multiferroic properties.

Keywords: *nanomultiferroic, electric voltage response, electric properties*

Root Caused Failure Analysis of Tube Pendant Superheater in 660 MW Coal Power Plant

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Abstract. Failure occurred in the tube pendant superheater that forced the plant to be shutdown. It was urgently needed to analyse the cause of the rupture. Material tube need to be prepared to test in the laboratory. The analysis methods were through mechanical tests which are visual observation, fractography, thickness test, hardness test, metallography or microstructure examination, and deposit analysis. The results showed that the tube failed due to overheating on the both side of the tube, combined of corrosion inside the tube a result of a deposit and slag outside of the tube. Overheating and under deposit corrosion decreased the hardness, thickness and tensile strength. The dominant element forming corrosion in the deposit mostly sodium and sulphur. As the oxide scales are increasingly developed on the inner tube and slag form on the outside tube could increase the metal temperature and decrease the hardness value in tube metal, thus could result very severe failure.

Keywords: *boiler, superheater, tube leakage, RCFA*

Corrosion Behavior of a Predeformed FeNi Lateritic Steel with Bainite Structure

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Abstract. In a railway track for intermodal usage between a train station to a port, an observation on corrosion behavior of the track alloy in coastal environment needs to be considered. In this study, a Fe-Ni lateritic steel with bainite structure is observed. This alloy is developed from lateritic ores in Indonesia as an alternative to the conventionally made Fe-Ni steels. This study aims to determine the effect of cold rolling and austempering processes on the corrosion properties of the alloy. The cold rolling reductions used are 30% and 70% followed by an austempering process at 400°C for 30 mins with air cooling. The corrosion test was performed on four different samples. First, a prior to deformation sample. Second, 30% and 70% cold rolled samples, Third, austempered without deformation samples. And fourth, deformed austempered samples. The corrosion test method occupied was the Copper Accelerated Acetic Acid Salt Spray (CASS Test) Method. Several samples with a dimension of 20 x 50 x 8 mm were sprayed with CASS Salt Solution (ASTM B 368) for 24, 48, and 96 hours. Afterward, a weight loss test was performed to calculate the corrosion rate of each sample. Furthermore, an observation on metallographic structure was carried out to correlate the resulted corrosion properties with the deformation and austempering processes.

Keywords: *bainite, cold rolling, corrosion, laterite, rail track, salt spray*

Effects of Manganese Addition on the Microstructures and Mechanical Properties of Cu-29Zn-0.5Al Alloys

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Abstract. Brass is an alloy with contents of Cu and Zn. This alloy is widely used for many application due to their good properties such as high strength, good ductility, good thermal conductivity and corrosion resistant. Normally, brass with Zn content up to 35 wt.% form the single phase of α, further the Zn content above 35 wt.% will promote the formation of β phase. Previous research showed that the addition of Al on brass alloy will accelerate the formation of β phase and change the microstructure and mechanical properties. On the other hand, addition of Mn on brass tend to increase the hardness, tensile strength and also elongation. In this research, Cu-29Zn-0.5Al-xMn alloys were produced by gravity die casting process using pure Cu, Zn and Al ingots as well as the Mn powder as the feeding materials. Mn addition was varied to 1, 2, and 4 wt.%. The molted metal was poured into 600 oC preheated metal mold with dimension of 100x100x6 mm3. As-cast samples were homogenized at 800 ^{0}C for 2 h in a muffle furnace. Samples characterization includes chemical composition analysis, microstructure observation, tensile and hardness testing. The results showed that addition of Mn for 4 wt.% promoted the formation of β phase, which is richer in Mn compare to that in the matrix. This phase dispersed in the grain and along the grain boundary with irregular forms. Significant increase in hardness, yield and tensile strengths was observed with addition of Mn. On the other hand, the addition of 4 wt.% Mn also tend to decrease the elongation.

Keywords: *Cu-29Zn, brass, aluminium, manganese, gravity die casting*

Aging and Degradation of Electrode Cu Spot Welding On The Thin Plate Low Carbon Steel

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Abstract. This study discusses how the spot welding process that needs to be considered is related to the use of electrodes and the quality of electrodes that can affect the quality of the welding results in the plate, taking into account the mechanical materials, in the welding process by several welding parameters such as welding time, pressure, current, temperature, and others, the electrodes used in pairs with the plate which need to know the age limit of use and the degradation of the electrode in order to control and know the quality of the electrodes and the results of spot welding. The purpose of this study, to determine the age limit of Copper (Cu) electrode use to the low carbon steel plate with a thickness of 1 + 1 mm. Microstructure and composition changes of the electrodes at the time of aging and post-degradation and shear strength on the plate during the aging experiments process. The method used was experimental, spot welding process with mechanical load and thermomechanical, electrode with Cu material with tip diameter 5 mm paired with plate using material low carbon steel with thickness (1 + 1 mm), first experiment to know the age limit aging electrode by loading of pressure 5 bar, current 5,7 kA ,welding time 0,72 s, and heating 0,3130 Joule, and second experiment is done to know degradation of electrode with loading pressure 5 bar, current 18,810 kA welding time 2,68 s and heating 16,025 Joule. The experimental results of the spot welding process, for the first experiment, resulted in a temperature of 710 OC with 5 bar and a continuous welding process of 500 spots was conducted, and the test results, metallography evaluation and composition of electrode before and after aging experienced changes, in the second experiment on the process welding produces a temperature of 1038o C and pressure of 5 bar, there is a significant change in the electrode surface. The electrode of spot welding Cu paired with plate low carbon steel, and thickness of plate 1+1 mm can be used continuously with 300 spot welds usage limits at temperature 710O C and temperatures occurring at the 900OC degradation threshold, with the recommended pressure parameter of less than 5 bar.

Keywords: *aging, degradation, electrode, spot weld, thin plate*

Analysis on Superheater Tubes Degradation at a Tangentially Fired Pulverized Coal Power Plant

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Abstract. Thinning of boiler tubing is one of common failure mechanism of coal-based boiler unit. An ultrasonic thickness testing (UT) is normally used to determine the state of boiler tube thickness and is done during yearly overhaul. The usefulness of thickness data can be problematic due to some fluctuation and irregularities in the data. In the present work, UT data from 4 years inspection will be analyzed with the aim to understand fundamental mechanism for thinning of the superheater tube. Some part of the UT data is analyzed to obtain thinning rate of the superheater tube. The thinning trend is the basis for predicting the value of thickness and can be confirmed by tube sampling in the selected position in the next inspection period.

Keywords: *superheater tubes, thinning, UT thickness test, damage mechanism, prediction*

Correlation of Holding Time and Bottom Ash Particle Size to Mechanical Properties of Polypropylene Composite

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Abstract. The availability of materials from mines such as metals and non-metals is increasingly diminishing. To overcome this problem it is necessary to find a new type of material. New materials sourced from nature, renewable, inexpensive and recyclable. A rapidly developing new material is a composite material that combines two or more different materials, one as a matrix and the other as reinforcement. In this study, the polypropylene polymer matrix was used as a matrix and bottom ash as reinforcement. The processing of bottom ash starts from crushing, filtering into sizes 200-250, 250-300, 300-350 mesh, cleaning/washing, and drying. Polypropylene polymer is heated to melt at a temperature of 170oC. Next, mix the bottom ash reinforcement with a melting polypropylene matrix and stirring at a speed of 20 rpm for 30 minutes. Then pour the composite material into the prepared mould, and give a pressure of 20 kg / cm2 for 5 minutes. From the results of tensile and bending tests, obtain the highest tensile strength in composites with particles 250-300 mesh and 30 minutes holding time of 40.48 MPa. Composites possess the smallest value with particles 200-250 mesh and a hold time of 90 minutes which is 25.7 MPa. For bending strength, the most excellent value occurs in composites with particles of 250-300 mesh and a duration of 30 minutes holding 103.56 MPa while the amount of the smallest bending strength in reinforced composites is bottom ash particles from 300 to 350 mesh, with a hold for 30 minutes, which is 59.1 MPa.

Keywords: *polypropylene matrix, bottom ash, tensile test, bending test*

Evaluation of Inhibitive Action from Papaya Leaf on Surface API 5L Grade B in Acid Solution

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Abstract. Corrosion is a change in material properties, especially metals due to reactions with the surrounding environment. Corrosion tends to reduce the quality of the material's mechanical properties. One way to inhibit corrosion is by adding inhibitors. Organic inhibitors are inhibitors that are considered environmentally friendly. In this study we will analyze the surface characteristics of the addition of papaya leaves as an inhibitor. The material used is API 5L Grade B steel in 1M HCl solution as a corrosive medium with the concentration of extract used in this study amounting to 0.5 - 2.5% of the amount of HCl solution. In this analysis, the results of polarization and FTIR testing data will be used later. Based on the results of tests that have been carried out, there is a decrease in the corrosion rate of API 5L Grade B steel in 1M HCl solution when added papaya leaf extract inhibitors. In the potentiodynamic polarization test the corrosion rate of the sample without inhibitors was 21.43 mm / year. While the testing with the largest addition of inhibitors of 2.5% the corrosion rate dropped to 0.4 mm / year with an efficiency value of 97%. This is the highest efficiency of all concentration variables performed.

Keywords: *inhibitor, papaya leaf, HCl, corrosion rate, polarization*

Natural Fiber Reinforced Composites as Bulletproof Panel Materials

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Abstract. The panel attached in bulletproof vest must fulfill the standard of NIJ 0101.06. It must resist the penetration of the bullet and has a back-face signature that doesn't exceed 44 mm by ballistic testing. This research included both numerical simulation and ballistic test for validation using type IV ballistic bullet. This research involved composite epoxy-HGM-hemp (Boehmeria Nivea) and epoxy-HGM-sisal (Agave Sisalana) as bulletproof panel materials with their woven-thickness characteristic. The properties of materials are obtained by performing ASTM D3039 test. As a result, by varying the thickness or each amount of layer, the thinnest panel of each material that fulfills standard of NIJ 0101.06 is obtained.

Keywords: *natural fiber, bulletproof, back-face signature*

Effect of Vehicle Speed to the Fatigue Life of a Coil Spring Based on Strain-Life Approach

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Abstract. This research aims to determine the fatigue life of an automotive coil spring driven with different speeds. A strain gauge was fixed at the critical point of the vehicle driven with the speeds of < 20 km/h, 40-50 km/h, and > 70 km/h. The strain signals obtained were analyzed using the Coffin-Manson, Morrow, and Smith-Watson-Topper models. According to the results, the lowest fatigue life of 3.5E+8 cycles to failure was obtained at speed > 70 km/h. This was 243 % lower than just as the vehicle was driven at the speed of 40-50 km/h, and 543 % lower at < 20 km/h. It concluded that, as the vehicle was driven at an accelerated speed, the stress received by the coil spring was higher, thereby significantly contributing to the fatigue life of the component.

Keywords: *strain, statistic, failure*

Tensile, flexural and water absorption properties of bamboo fiber/unsaturated polyester composites: Effect of calcium carbonate content

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Abstract. Adding low cost filler such as calcium carbonate (CaCO3) into natural fiber reinforced polymeric matric composites have several advantages. In this paper, CaCO3 was used to fill the bamboo reinforced unsaturated polyester composites. Two volume fractions of bamboo fibers had been used with the CaCO3 content varied from 2.5 to 10 (wt%). The tensile and flexural properties were used to characterize the composites. In addition, the water absorption and its effect of flexural properties had also been conducted. Adding CaCO3 up to 10wt% tended to decrease the tensile properties of bamboo fiber/ modified unsaturated polyester composites, however it did significant effect of the flexural properties. Similarly, CaCO3 did not significantly affect the water uptakes and the flexural properties of bamboo fiber/modified unsaturated polyester composites in wet condition.

Keywords: *calcium carbonate, bamboo fiber, unsaturated polyester, water absorption, mechanical properties*

Effects of Oil Palm Empty Fruit Bunch and Magnesium Oxide Volume Fraction on Mechanical Characteristics of Railway Brake Block Composite Material

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Abstract. Railway brake blocks are the most important component of braking system during the braking process. Materials railway brake blocks are generally made of metal or composite. The metallic brake blocks have some disadvantages that are heavy, low wear resistant and caused spark, otherwise the composite brake blocks have some advantages that are light, high wear resistant and do not caused sparks. Furthemore, composites made from natural fibers have environmental advantages over non-natural fibers. Natural fiber from oil palm empty bunches is a waste from the production of palm oil which can be reused, one of which is a composite constituent. The composite brake blocks manufactured by oil palm empty bunches as reinforcement and phenol resin as matrix with filler alumina, magnesium oxide and iron powder as friction modifier. Density, Hardness, Coefficient of Friction, Compressive Strength and Flextural Strength testing was carried out to determine the mechanical characteristic of the composite railway brake block material that was influenced by a combination of the volume fraction of oil palm empty fruit bunches in the composite material. Based on the requirements of PT. Kereta Api Indonesia for railway brake block, the test results were obtained density 1,96 g/cm³ (sample 3), hardness 57,6 HRB (sample 3), coefficient of friction 0,43 (sample 2), compressive strength 37.1 Mpa (sample 3) and flextural strength 33 Mpa (sample 1). There are 3 sample of volume fraction combination with 20% of oil palm empty fruit in sample 1 and decrease by 10% to sample 2 and sample 3. Base on the test result show that composite with volume fraction 10% oil palm empty fruit 10%, phenolic resin 30%, Al_2O_3 25%, MgO 20%, iron powder 15% give recommendation of alternative composite railway brake block material.

Keywords: *composite, oil palm empty fruit bunch, magnesium oxide, friction modifier*

Analysis of Condensor Tube Thinning Distribution and Their Failure Modes Based on Eddy Current Data

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Abstract. Condenser in Steam Power Plant is an important equipment to convert steam from the steam output of the low pressure turbine to become liquid. The water from the condensor is circulated into the boiler for later usage. Maintaining the realibility of the condensor will prevent progressive failure toother equipment. The eddy current test can measure the thinning level of the condenser tube thus prevention of tube leaking can be avoided by plugging the critical tube having thinning level of 90% which equal to 0.05 mm compared to original thickness of 0.5 mm In 2018, the condenser unit 2 of the Labuan steam power plant was tested for eddy current on all tubes. One tube with thinning of 80% was taken to the laboratory and metallography testing, SEM and EDS were performed on that sample. Statistical distribution of tube thinning analysis based on eddy current data obtained in this unit, can be used as a reference for maintenance strategies such as performing sampling control thickness measurement of the tube on selected position which have highest probability of leaking due to wall thinning in the next inspection period.

Keywords: *condenser, wall thinning, eddy current, SEM, EDS, metallography*

Carbon and Nitrogen Composition for Non-Precious Metal Catalyst to Physical Characterization and Electrochemical Properties

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Abstract. Considering the raw material of balloon-expandable stent that usually obtained from tube-type geometry, it is still unclear how the multilinear isotropic model obtained from flat-type test piece can be used to represent the actual behavior of stent expansion. In this experimental study, non-standard sheet-type and tube-type tensile test specimens are prepared, which are made from stainless steel 316L. The geometry of sheet-type and tube-type specimens for the tensile test. To assure equality of both chemical composition, the testing is carried out using Optical Emission Spectrometer. All type of specimen undergoes tensile test up to permanent failure. For the tube-shaped (axial and tangential), three pieces of specimens are prepared for the tensile test. The stresses and strains are recorded in order to generate stress-strain relationship and then compiled for analysis. The study indicated that the correlation between the stresses and the strains was not similar among those geometry of specimens. Tangential specimen experienced increasing of strain faster than that of stress. It differed significantly compared to the sheet-type specimen. A moderate correlation between the stress and the strain is obtained by the tube-shaped axial specimen. To verify the existed tendency, it is necessary to identify the plastic deformation on the specimens using numerical study.

Keywords: *balloon-expandable stent, tensile property, tube-shaped specimen*

Natural Fiber Reinforced Composites as Bulletproof Panel Materials

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Abstract. The panel attached in bulletproof vest must fulfill the standard of NIJ 0101.06. It must resist the penetration of the bullet and has a back-face signature that doesn't exceed 44 mm by ballistic testing. This research included both numerical simulation and ballistic test for validation using type IV ballistic bullet. This research involved composite epoxy-HGM-hemp (Boehmeria Nivea) and epoxy-HGM-sisal (Agave Sisalana) as bulletproof panel materials with their woven-thickness characteristic. The properties of materials are obtained by performing ASTM D3039 test. As a result, by varying the thickness or each amount of layer, the thinnest panel of each material that fulfills standard of NIJ 0101.06 is obtained.

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Keywords: *Strain, Statistic, Failure*

Tensile, flexural and water absorption properties of bamboo fiber/unsaturated polyester composites: Effect of calcium carbonate content

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Keywords: *Calcium Carbonate, Bamboo Fiber, Unsaturated Polyester, Water Absorption, Mechanical Properties*

Effects of Oil Palm Empty Fruit Bunch and Magnesium Oxide Volume Fraction on Mechanical Characteristics of Railway Brake Block Composite Material

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Abstract. Railway brake blocks are the most important component of braking system during the braking process. Materials railway brake blocks are generally made of metal or composite. The metallic brake blocks have some disadvantages that are heavy, low wear resistant and caused spark, otherwise the composite brake blocks have some advantages that are light, high wear resistant and do not caused sparks. Furthemore, composites made from natural fibers have environmental advantages over non-natural fibers. Natural fiber from oil palm empty bunches is a waste from the production of palm oil which can be reused, one of which is a composite constituent. The composite brake blocks manufactured by oil palm empty bunches as reinforcement and phenol resin as matrix with filler alumina, magnesium oxide and iron powder as friction modifier. Density, Hardness, Coefficient of Friction, Compressive Strength and Flextural Strength testing was carried out to determine the mechanical characteristic of the composite railway brake block material that was influenced by a combination of the volume fraction of oil palm empty fruit bunches in the composite material. Based on the requirements of PT. Kereta Api Indonesia for railway brake block, the test results were obtained density 1,96 g/cm³ (sample 3), hardness 57,6 HRB (sample 3), coefficient of friction 0,43 (sample 2), compressive strength 37.1 Mpa (sample 3) and flextural strength 33 Mpa (sample 1). There are 3 sample of volume fraction combination with 20% of oil palm empty fruit in sample 1 and decrease by 10% to sample 2 and sample 3. Base on the test result show that composite with volume fraction 10% oil palm empty fruit 10%, phenolic resin 30%, Al_2O_3 25%, MgO 20%, iron powder 15% give recommendation of alternative composite railway brake block material.

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Analysis of Condensor Tube Thinning Distribution and Their Failure Modes Based on Eddy Current Data

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Abstract. Condenser in Steam Power Plant is an important equipment to convert steam from the steam output of the low pressure turbine to become liquid. The water from the condensor is circulated into the boiler for later usage. Maintaining the realibility of the condensor will prevent progressive failure toother equipment. The eddy current test can measure the thinning level of the condenser tube thus prevention of tube leaking can be avoided by plugging the critical tube having thinning level of 90% which equal to 0.05 mm compared to original thickness of 0.5 mm In 2018, the condenser unit 2 of the Labuan steam power plant was tested for eddy current on all tubes. One tube with thinning of 80% was taken to the laboratory and metallography testing, SEM and EDS were performed on that sample. Statistical distribution of tube thinning analysis based on eddy current data obtained in this unit, can be used as a reference for maintenance strategies such as performing sampling control thickness measurement of the tube on selected position which have highest probability of leaking due to wall thinning in the next inspection period.

Keywords: *Condenser, Wall Thinning, Eddy Current, Sem, Eds, Metallography*

Carbon and Nitrogen Composition for Non-Precious Metal Catalyst to Physical Characterization and Electrochemical Properties

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Abstract. Considering the raw material of balloon-expandable stent that usually obtained from tube-type geometry, it is still unclear how the multilinear isotropic model obtained from flat-type test piece can be used to represent the actual behavior of stent expansion. In this experimental study, non-standard sheet-type and tube-type tensile test specimens are prepared, which are made from stainless steel 316L. The geometry of sheet-type and tube-type specimens for the tensile test. To assure equality of both chemical composition, the testing is carried out using Optical Emission Spectrometer. All type of specimen undergoes tensile test up to permanent failure. For the tube-shaped (axial and tangential), three pieces of specimens are prepared for the tensile test. The stresses and strains are recorded in order to generate stress-strain relationship and then compiled for analysis. The study indicated that the correlation between the stresses and the strains was not similar among those geometry of specimens. Tangential specimen experienced increasing of strain faster than that of stress. It differed significantly compared to the sheet-type specimen. A moderate correlation between the stress and the strain is obtained by the tube-shaped axial specimen. To verify the existed tendency, it is necessary to identify the plastic deformation on the specimens using numerical study.

Keywords: *Balloon-Expandable Stent, Tensile Property, Tube-Shaped Specimen*

Effect Of Sulfuric Acid Concentration On The Corrosion Rate Of ASTM A213-T12 Steel

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Abstract. Even though carbon steel is susceptible to corrosion degradation, carbon steel is widely used for applications in the industry. Impurities in steel composition are known to affect the corrosion properties. However, for a specific application in this case liquid containing sulfuric acid, the rate of corrosion dependence on the acid concentration is not well determined. The present work is conducted to determine the effect of sulfuric acid concentration on the corrosion rate of power plant steel ASTM A213-T12 with a solution concentration from 0.01-0.05 M H2SO4. The corrosion rate was determined by using an immersion test as well as polarization method using a potentiostat. The result shows that increasing the concentration of sulfuric acid molarity; corrosion rate tended to increase. Furthermore, the effect of phosphor contents significantly affects the corrosion rate in which steel with high phosphor contents has a high corrosion rate.

Keywords: *carbon steel, polarization, sulfuric acid, corrosion rate*

Analysis The Effect Of Charcoal Mass Variation To Ni Content, Sinter Strength and Yield On Sintering Process Of Limonitic Laterite Nickel Ore

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Abstract. Depletion of sulphide nickel ore and the growing of stainless steel demand each year cause the use of low grade laterite nickel ore continues to increase. Due to very low nickel content, there is no optimal process to extract them. One of the alternative process being developed now is sintering-blast furnace process which produces ferronickel. This research was conducted by sintering limonitic laterite nickel ore using charcoal as fuel and limestone as flux. The aim of this research is to analyze the effect of charcoal mass variation to Ni content, sinter strength and yield on sintering process of limonitic laterite nickel ore. Charcoal and limestone demand calculated using energy balance and mass balance, then varied charcoal mass to feed material. Feed materials are fed in furnace, heated at temperature of 1200oC with 4 hours holding time. Next, sinter yield is calculated. EDX, XRD and Drop test were also performed to determine Ni content, sinter compounds and strength. The highest Ni content obtained by adding 9.9 kg charcoal which was 3.66%. The highest sinter strength and yield also obtained by adding 9.9 kg charcoal which was 72.30% and 86.44%. Mayor phases which formed on sinter with 9.9 kg charcoal addition is nickel iron oxide.

Keywords: *laterite nickel sintering, charcoal mass, Ni content, sinter strength, sinter yield*

Direct Reduction of Limonitic Laterite Nickel Ore with Variation Type of Reductor to Fe, Ni Content and Recovery by using Coal-Dolomit Bed Method

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Abstract. The utilization of low grade laterite nickel ore continues to increase as demand for stainless steel and sulphide ore supply decreases. The direct reduction process can increase the nickel content of limonite laterite by using CO and CO2 as reducing agents. CO and CO2 gases in the reduction atmosphere are obtained from the addition of reducing agents (coal, charcoal, green coke) and dolomite flux to the reduction process. This research aims to study the effect of redactor type on nickel limonitic nickel briquettes on Ni and Fe content and recovery of Ni and Fe. The briquettes are reduced by heating to a temperature of 1400oC with a holding time of 6 hours. The EDX and XRD tests were performed to determine the levels and recovery of Ni and Fe. The highest Ni content was obtained by using green coke reductor which was 15.23%. The highest Fe content was obtained by using coconut shell charcoal reductor (61.22%). The highest Ni recovery (96%) was obtained by the addition of green coke redactor. On the other hand, the highest Fe recovery (18.8%) was obtained by the addition of coal reductor.

Keywords: d*irect reduction, coal, charcoal, green coke*

The Effect of Citric Acid Concentration on Corrosion Behavior of Austenitic Stainless Steel 316 L

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Abstract. The objective of the present study is to understand the corrosion behavior of austenitic stainless steel in a water solution containing 9 wt. % NaCl mixed with citric acid at different levels of concentration. Immersion test and polarization measurement were conducted to quantify the corrosion rate and polarization behaviors. The result shows that the shape of polarization curves and the corrosion rate are pH dependence. An increased citric acid concentration until the pH value of 4 will enhance the passive film development, but the further increase aggravate the corrosion attack.

Keywords: *citric acid, corrosion, austenitic stainless steel*

Deformation Analysis of Internal Fixation Plate on Femur Bone Fracture Considering Material Variation

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Abstract. In the case of femur bone fracture, internal fixation is usually applied for the treatment due to the convenience and amenities of follow-up care. Due to a high demand for internal fixation implants in Indonesia, causing Pelopor Teknologi Implantindo Inc. (PTI Inc., Mojokerto - Indonesia) produces implant material made from annealed stainless steel 316L, with a yield strength of 290 MPa and ultimate tensile strength of 580 MPa. Compared to implant material in ASTM F138, it has a little higher ultimate tensile strength in the material properties. To determine the effects of the various material strength of internal fixation plates, normal stresses will be analyzed to evaluate the strength of implant material, safety factors and rate of healing. In the case of a broken bone, the transversal-type fracture is chosen for fracture modeling. The loading is taken from an extreme body weight of Asians, i.e. 100 kg. The provisional simulation result indicates that there is no significant influence on the bone healing caused by different material of internal fixation plate.

Keywords: *internal fixation plate, bone fracture, femur bone, normal stresses*

Effect of Stirring on the Quality of ADC 12 Cast Aluminium Alloy

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Abstract. Stirring is one of the most utilized processes in small foundry. It is used for homogenizing the temperature and mixing process during melting. However, stirring may cause undesirable effect to the quality of castings if it is not managed properly. Bifilm is one of the defects that can be detrimental to the quality of aluminium castings, and its formation can be related to the stirring during melting. The research aim is to investigate the effect of stirring during melting of cast aluminium alloys. The quality of castings is approached by the term of bifilm index and mechanical properties. ADC 12 cast aluminium alloys is used in the experiment. The ADC 12 ingots are melted at 720 □C, and then stirred for 0, 3 and 5 minutes. Reduced Pressure Test is used for determining the bifilm index. Samples for mechanical testing are also casted into specific geometry. Results indicate that prolonged stirring time increases the bifilm index, indicating that more porosity and bifilm oxide are formed. Extended stirring time instigates more turbulence in liquid metal, hence surface oxides are folded and trapped in the bulk liquid metal. Charpy impact test, hardness test and tensile test have also carried out. More Porosity and bifilm oxide are formed in the samples and tend to decrease the mechanical property.

Keywords: s*tirring, small foundry, bifilm, cast aluminium alloys, mechanical properties*

Impact Toughness Characteristics of SM570-TMC Steel Joint Using Welding Wire Containing 0.4% Nickel at Different Level of Heat Input

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Abstract. The study was conducted to evaluate the impact toughness of flux-cored arc welded of SM570-TMC steel joint under different heat inputs, 0.9 kJ/mm (low heat input) and 1.6 kJ/mm (high heat input). Welding wire containing 0.4%Ni was selected on this experiment. Multi-pass weld metals were performed on SM570-TMC steel plate of 16 mm in thickness with a single V-groove butt joint on flat position (1G). The evaluation consists of observations on microstructure using an optical microscope and SEM-EDS, and mechanical properties including tensile, microhardness Vickers and Charpy V-notch (CVN) impact test at temperatures of 25, 0 and -20 °C. Results showed that the impact toughness of the base metal was higher than the weld metal at all test temperatures. Hardness and impact toughness of weld metal at low heat input was observed higher than when applied a high heat input. The welded samples at low and high heat inputs had high of tensile strength, and the fracture seemly occurs on the base metal. Microstructure observation showed that at a high heat input, larger grains and microsegregation were observed. It might affect on decreasing their impact property.

Keywords: *Microstructure, Impact toughness, SM570-TMC, Heat input, Weld metal*

Non-monotonous Effect of The Adhesive Thickness on The Stiffness of Adhesive Butt Joint at High Strain Rate Loading

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Abstract. Investigation on the mechanical properties of adhesive joint contributes to the development of lightweight structures. This paper investigates the dynamic responses of adhesive butt joint loaded at high strain rate of 600 s-1 using split Hopkinson pressure bar (SHPB) tests. The joint consisted of identical cylindrical aluminum adherends bonded by epoxy adhesive with varied thickness. The results show that the Young's modulus of joint increases non-monotonically with adhesive thickness and the joint resists higher stress as the thickness increases. There is an optimum adhesive thickness that maximize the joint stiffness.

Keywords: *Adhesive joint, high strain rate, Hopkinson bar, stress-strain, stiffness, epoxy, Butt joint*

Failure Investigation of A Steering Bearing in Matic Motorcycle 125 cc

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Abstract. Most of transportation in Indonesia are land vehicles, one of them is motorcycle. Motorcycle is light transportation vehicles that has a lot of system that works together and link each other such as chasis system, power train system (engine), brake system, electrical system, suspention system etc. Bearing is one among others supporting part in motorcycle. It's steering bearing and wheel bearing. Steering bearing is usualy exchange faster than wheel bearing. This study is to reveal the cause of the failure on steering bearing in motorcycle. Steering bearing is thrust bearing type that able to support axial force, transfersal force and also impact force. Study on failed bearing was made including visual examination, micro hardness, microstructure, chemical composition and scanning electron microscope (SEM) studies, and compare the new bearing with the failed bearing. Failure was happened in steering bearing because of miss assembling, over load carrying, bad road condition and lack of grease.

Keywords: *Bearing, Motorcycle, Failure*

Numerical convergence in wear volume prediction of UHMWPE acetabular cup paired with cp Ti femoral head hip implants

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Abstract. Wear is a problem for metal on polymer (MOP) hip implants to perform lifetime endurance. Excessive polymer worn volume would lead to implant failures. Attempts to solve this problem are usually initiated with tribological tests. The method is time consuming because it must be performed in a low frequency of one Hz dynamic sliding. Other way capable to gather data faster is the computational method. The aim of this research is to assess numerical convergence needed to obtain an accurate wear volume prediction. An MOP biomaterial pair of commercially pure titanium (cp Ti) and ultra-high molecular weight polyethylene (UHMWPE) hip implants was modeled. Paul physiological load was applied to the model. Polymer wear volume was calculated with a nonlinear load and contact area equation. Wear factor needed by the calculations was acquired experimentally with pin on disc tests. Predicted wear volume was validated with experimental data from literature. Contact mechanic parameters gained numerically contribute to the wear volume. Contact load shows a trend of convergence while others such as contact pressure and contact area are not. The accuracy of the prediction is up to 0.53%.

Keywords: *Wear prediction, UHMWPE, cp Ti, hip implant*

Dissimilar Joining Metal of Aluminum 6061 and Galvanis Pipe Using Friction Welding Method

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Abstract. The welding process is usually performed for joining, similar material.This research aims to study similar metals at low carbonese ST 37 with friction welding method. Traditional welding the electrode used, than welding result dirty, slag, crack and also deformation cause residual stress usually. In this study, the specimens used are in galvanized pipes with a 1.5 " diameter, 110 mm long and bushing made with aluminum 6061 which has 1.5 " diameter with 30 mm long. The process of friction welding is done using a lathe with a speed of 860 rpm. The purpose of this study is to find out how strong the weld, the hardness value, and the micro structure result by doing friction welding method. The result of this research is bushing connection and galvanized pipe at welded area with temperature 225.8 ° C are 127,68 VHN and 55,86 VHN. The largest value of the tensile strength test is 8380N Key words: Friction Welding, Bushing, Galvanized

Keywords: *Friction Welding, Bushing, Galvanized*

Extraction and Characterization of Nanocrystalline Cellulose (NCC) from Ramie Fiber by Hydrochloric Acid Hydrolysis

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Abstract. The present study investigates the structural, crystallinity index, crystallite size and dimension of Nanocrystalline Cellulose (NCC) extracted from ramie fiber by hydrochloric acid-hydrolysis. NCC was chosen because it has high strength and modulus compared to other natural materials. Ramie fiber was chosen because it has high cellulose content and abundant in Indonesia. The other reason is ramie has a high crystallinity index compared to other natural fibers. The extraction process carried out into two stages: cellulose purification then followed by hydrochloric acid hydrolysis. The characterizations of nanocrystalline cellulose were conducted through Fourier-Transform Infrared spectroscopy (FTIR), X-ray diffraction (XRD) and Particle Size Analyzer (PSA). Focus of this research is to study about the effect of acid concentration on the characteristics of nanocrystalline cellulose. The results showed that nanocrystalline cellulose can be extracted through hydrolysis using hydrochloric acid and hydrolysis by hydrochloric acid proven which does not have effect to the chemical compound of cellulose. The higher of the acid concentration used for hydrolysis, the smaller of the NCC dimensions produced but crystallinity index decreased.

Keywords: *Nanocrystalline Cellulose, ramie fiber, Hydrochloric Acid, hydrolysis*

Plug and Play Manhole Kit Holder for Storage Tank: A Comprehensive Design Analysis

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Abstract. A novel design of manhole kit holder, namely as "Plakhor" was developed by TBBM Boyolali of PT Pertamina (Persero). The device has an advantage of a plug and play system which has an important feature to assist the cleaning of storage tank confined space. The present report addressed the design considerations, mechanical test result, and stress analysis of the developed device. The design was developed by considering engineering standards of API 650 while the stress analysis was conducted using finite element analysis (FEA). Meanwhile, a series of mechanical tests such as tensile strength, bending, press, and torsion were also conducted to determine the mechanical strength of the material used in this design. The stress analysis results indicated that the design construction was safe enough to hold the manhole weight and in a good agreement to that of the physical test result

Keywords: *Manhole kit holder, Storage tank, Plug and play holder, Stress analysis*

Manufacture

Optimization of Welding Parameters Effect of Metal Inert Gas on a Steels Joint

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Abstract. The welding parameters affected to weld joint performance. Tensile tested value of combination from each welding parameters difference so optimization could help to know the some weld parameter combinations affected to the tensile strength optimize. Response Surface Method (RSM) was used to optimize the effect of welding parameters to tensile strength. Welding current (Amp), Wire speed (inch/min), and Welding speed (mm/sec) were used as treatment variable and tensile strength was used as respond variable. Each welding parameters combination was optimized by RSM graphic.

Keywords: *optimization, metal inert gas, steel joinh*

Multi Objective Optimization in End-Milling of Carbon Fiber Reinforced Polymer Using Backpropagation Neural Network-Ant Colony Optimization

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Abstract. Carbon fiber-reinforced plastic (CFRP) composites are considered difficult to machine materials due to the anisotropic and heterogeneous properties of the material. The end milling process of these materials causes high surface roughness and delamination owing to the excessive cutting forces generated. The reduction of surface roughness and damage is an important aspect for product quality. Therefore, an experimental study was carried out on end milling of CFRP composites materials to determine the levels of the end milling parameters for minimizing cutting force, surface roughness, and delamination. End milling tests were performed at CNC vertical milling machine. In the experiments, parameters considered for the end milling of CFRP were spindle speed, feed rate, and axial depth of cut. The combination of back propagation neural network (BPNN) and ant colony optimization (ACO) method was applied to predict and to minimize cutting force, surface roughness, and delamination.

Keywords: *ant colony optimization, backpropagation neural network, carbon fiber reinforced polymer, end millling*

Optimizing the Machining Conditions on Friction Stir Welding of Aluminum Alloy through Design Experiments

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Abstract. Friction stir welding is a welding technique widely used in the industrial field, especially for connecting aluminum alloys in space, shipping, automotive, defense, and other applications in other sectors. In this study, the process of welding aluminum alloy 6061 with the Friction Stir Welding method was carried out using a vertical milling machine. The main purpose of this research is to optimize machining conditions (rotational speed and feed rate) on the hardness and tensile strength of welds. Machining conditions are optimized using the experimental design method. The optimal result is that the ultimate tensile strength can reach 192.129 MPa and the hardness value is 66.818 HB.

Keywords: *friction stir welding, allumunium alloy, response surface methodology, tensile strength, hardness*

Effect of a Dissimilar Thin Plate Joint of Metal Inert Gas

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Abstract. Each metal has difference properties, the Advantech's metals can be joined by welding process or dissimilar welding. Thermal properties of the metals which will be joined are the problem of the dissimilar welding. Many researchers studied dissimilar welding, this study discuses dissimilar welding of SS304 with Carbon Steel thin plate. Mechanical properties in this study a tensile tested represent weld performance.

Keywords: *dissimilar, thin plate joint, metal inert gas*

Effect of grain size on silica blasting processes on the roughness of medical grade SS316L

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Abstract. The paper presents the effect of size and repetition process on silica blasting on the surface character of Medical Grade SS316L. In this study, topography and surface roughness of SS316L will be evaluated both using optical and stylus methods. Medical Grade SS316L was blasted using silica sand with a mesh size of 10-30 (then called K), mesh 40-60 (then called S), and mesh 70-90 (then called H). Silica blasting processes was carried out on the surface of Medical Grade SS316L at room temperature, 90° of nozzle direction, and 7 bar of nozzle pressure. The silica blasting process was carried out by varying the treatments of K, S, H, KH, and SH for 20 seconds each. The results show that roughness increases with the size of silica sand, besides that the repetition of the H process on the K and S (KH and SH process) will refine the surface of the silica blasting results in the S and K process but when compared to H is relatively coarse.

Keywords: *silica blasting, SS316L, surface roughness, implant material*

Development of Tools Utilization Monitoring System on Labor-Intensive Manufacturing Industry

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Abstract. Common manufacturing industries in Indonesia are labor-intensive industries. Implementation of industry 4.0 in labor-intensive manufacturing industries becomes a crucial issue for today. Industry concept 4.0 requires a well-connected and transparency data between each the production element. This could be realized through the cyber-physical system as a bridge of the production elements in the real world with object models in the virtual world. The aims of this study were to build a cyber-physical work-station system as a tools monitoring system for obtaining real-time information of actual tools utilization, especially for hand tools which been used regularly on labor-intensive manufacturing industries. The use of cyber-physical workstation system model could be the best method for determining the actual production tool utilization with simple architecture, low cost and minimum negative impact. Workstation monitoring system processes attendance data tools in the work area and start-finish operation time event be actual tool utilization information. The major contribution is an implementation of industry 4.0 in labor-intensive manufacturing industry by using cyber-physical workstation system is described and is show how it can achieve the usage time of each tool on each production operation could be monitored. Furthermore, the estimation of the actual duration of each tool utilization can be calculated. It will be further used as primary data input for building smart tools model.

Keywords: *industry 4.0., cyber – physical workstation system, monitoring system, actual tools utilization*

Analysis of Chips Formation in Subtractive Manufacturing for Working Safety

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Abstract. Subtractive manufacturing is the most implemented for metal processing to make products in the world. Chips formation is the distinctive characteristic of subtractive. There are three types of chips in general which are: continuous, serrated and discontinuous. Characteristics of chips are affected by some factors including the characteristics of materials, cutting parameter and cooling fluid. Size and type of chips have effects in cutting tool lifetime and further to the machine lifetime itself. There were several studies about them and even utilizing the Finite Element Method to predict the chips generated. However, there were very few focusing on the effect of chips formation to working safety. This safety topic is important because of the trend of manufacturing process toward lean manufacturing. The principal is 5S which includes sort, set in order, shine, standardize and sustain. In this study, it will present the type and size of chips recommended for working safety by changing the cutting parameter. The desired chip shape is discontinuous, so cutting parameters to improve the process is the depth of cut 2 mm and feed 0,1 mm/rev.

Keywords: *substractive manufacturing, metal processing, cutting parameter, working safety, lean manufacturing*

Effect of Feeding and Depth of Cut on Surface Roughness in Truing and Dressing Process Using Cylindrical Grinding Machine

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Abstract. The automotive industries leaned toward a decentralized approach since the booming of the products in the last century. The leading among them has the principal mostly in the growth countries and the plant mostly in developed ones. However, there is a technological gap between the principal and the plants. So, the problem arises when some processes couldn't be done in the plant. In order to narrow that gap, the study is conducted about the maintenance in the honing process. Honing is one type of finishing to ensure the surface quality of the product. The process could be categorized into subtractive manufacturing. The distinct characteristic of subtractive manufacturing is the cutting tool. The quality of the tool has to be better than its working piece. In other words, in the case of honing, the surface roughness and the form of the tool has to be controlled tightly. In this study, the honing tool must be corrected by trueing and dressing. Trueing and dressing are done simultaneously by grind the honing tool using a cylindrical grinding machine. Parameters dominant in the trueing and dressing process are feeding and depth of cut. The processes are tried by varying 10 feeding value and 4 depth of cut value. From those parameter variations, the roughness then measured. It could be inferred that the bigger the feeding the coarser the roughness.

Keywords: *honing, substractive manufacturing, trueing, dressing, surface roughness, cutting parameters*

Multi Objective Optimization in End-Milling of Carbon Fiber Reinforced Polymer Using Backpropagation Neural Network-Genetic Algorithm

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Abstract. Carbon fiber reinforced polymer (CFRP) are utilized in large numbers of application, which demand good weight to strength ratio, high-temperature strength, thermal stability, stiffness, and extreme corrosion ability. Most of CFRP used to substitute various aerospace metal parts. The milling process is one of the important machining processes in making components from composite materials. The milling process is used to form surface contours and obtain accurate product dimensions at the final stage. To obtain best composite material machining results, it is necessary to select the correct machining parameters such as depth of cut, feed rate, and spindle speed. This study investigated the effect of depth of cut, feed rate, and spindle speed on delamination damage and surface roughness on the end milling process of CFRP composite. This study uses a full-factorial 2x3x3 experimental design. The machining parameters chosen are two levels of depth of cut, three levels of feed rate and spindle speed. Backpropagation neural network was utilize to predict the delamination damage and surface roughness. Genetic algorithm has two purposes. First, to determine the BPNN network architecture that can produce a minimal mean square error to precisely predict delamination damage and surface roughness. Second, to find the best setting of depth of cut, feed rates, and spindle speed that can minimize delamination damage and surface roughness simultaneously during the end milling process of CFRP composite. The best BPNN network structure was 3 neurons in input layers, one hidden layer with 3 neurons, and 2 neurons in output layer, with tangent sigmoidal activation function. The setting of the end milling parameters that can minimize the surface roughness and delamination response values simultaneously on end milling CFRP material by using BPNN-GA is depth of cut 1 mm, feeding speed of 29.4 mm/min , and spindle speed of 3425 rpm.

Keywords: *optimization in end-milling, carbon fiber reinforced polymer, backpropagation neural network-genetic algorithm*

Effects of Processing Parameters on The Tensile Strength of Injection Moulding Unidirectional Glass Fiber Reinforced Polypropylene Composite

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Abstract. Composite is a type of material that has rapid development today. The study and development of science and technology related to this material is mostly carried out with various purposes. In this study, we will discuss about glass fiber reinforced polymer (GFRP) which consist glass fiber as reinforcement element and polypropylene as matrix. This composite is manufactured using MEIKI M-70B injection moulding machine. In manufacturing this composite, a combination of melting temperature and hydraulic pressure was carried out using Taguchi design of experiment. Taguchi design of experiment help us to find what is the most influence processing parameters in making this composite by eliminating a number of experiments. And we also use ANOVA to find the percentage contribution of each parameters. Furthermore, tensile test will be applied to the composite to obtain the composite tensile strength.

Keywords: *composite, glass fiber, polypropylene*

The Phase Transformation of CP-Titanium Grade 2 and AISI 316 L in Cardiovascular Stent Manufacturing by Die Sinking EDM

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Abstract. The aim of this research is to investigate the effect of the EDM process on the phase transformation of the microstructure of AISI 316 L and CP-Titanium grade 2 in cardiovascular stent manufacturing. The phases transformation was observed by an optical light microscope, and the microhardness test is conducted by microhardness vikers to validate the phase that is formed in the material. The pulse currents which were used in the manufacturing of stent by die sinking EDM were 1.5 A and 6.0 A. The experimental results show that the phase transformation of microstructure after EDM in cardiovascular stent manufacturing occurs in the material CP titanium grade 2, and it does not occur in the material AISI 316 L. The phase transformation of CP titanium grade 2 is from equiaxed α to be α' martensite for the pulse current 6.0 A, and equiaxed α to be TiH for the pulse current 1.5 A. The hardness of equiaxed α, α' martensite, and TiH are 108 Mpa, 113 Mpa, and 254 Mpa, respectively. The HAZ only occurs in the CP-Ti 2, and its depth for 1.5 A and 6.0 A are 45 μs and 73 μs, respectively.

Keywords: *cardiovascular stent, electric discharge machining, AISI 316 L, cp-titanium grade 2*

Effect of Punch Angle and Punch Radius on Bending Angle through V-Bending Process of Sheet Metal

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Abstract. Nowadays, the process of metal forming in the industrial of welding and machinery is developing very rapidly, especially the bending process. In the manufacturing process, bending processes are often carried out to make and repair products such as electronic panel components, automobile vehicle panels, tool boxes, burning fish, agricultural machinery and mechanization tools etc. An experimental study was conducted to determine the effect of punch parameters (i.e. radius and angle) on the bending angle produced in the V-bending process. Bending tests carried out several variable variations, including the punch angle (i.e. 85º, 87.5º and 90º), and punch radius (i.e. 1 mm, 1.5 mm and 2 mm). The angle of 85º of die is constant. It can be concluded that the punch angle is significantly affect to the bending angle produced (less than 90º or more than 90º) while compared to the punch radius.

Keywords: *v-bending process, punch angle, punch radius, sheet metal*

Prediction of Cutting Force in End Milling of Glass Fiber Reinforced Polymer (GFRP) Composites Using Adaptive Neuro Fuzzy Inference System (ANFIS)

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Abstract. The anisotropic and heterogeneous properties of glass fiber-reinforced plastic (GFRP) composites causes these materials difficult to machine. The end milling process of these materials causes high surface roughness and delamination owing to the excessive cutting forces generated. The minimization of surface roughness and delamination is an important aspect for the quality of product. Therefore, it is necessary to predict the cutting force, surface roughness, and delamination during the end milling of CFRP composites materials. In the experiments, parameters considered for the end milling of CFRP composites were spindle speed, feed rate, and axial depth of cut. The end milling tests were performed at CNC vertical milling machine. Adaptive Network-Based Fuzzy Inference System (ANFIS) method is applied to predict the cutting force, surface roughness, and delamination in end milling of GFRP composites.

Keywords: *end-milling, glass fiber reinforced polymer (GFRP) composites, adaptive neuro fuzzy inference system (ANFIS)*

Process Simulation Based on 3D Printed Vero-Clear to Produce Injection Mold Inserts

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Abstract. In this paper, 3D printed vero-clear material is performed according to the simulation result. The aim of this research is finding optimal parameters for both injection molding insert core and insert cavity. The simulation starts from setting parameters of thermoplastics part including polypropylene material and mechanical properties to the software simulation. While injection molding process parameters that consist of melt temperature 215°C, mold temperature 50°C, injection volume 13.42 gram, packing time 30 seconds, cooling time 50 seconds, and cycle time about 90 seconds are assigned for the simulation procedure. The results are satisfying that the condition of the printed insert core and cavity is capable to handle more than 50 parts according to the simulation of thermal distribution before the insert mold components are broken. Therefore, the parameters in both product and process of injection molding can be used as references for producing limited plastic parts quickly and durable.

Keywords: *injection molding, rapid tooling technology, vero clear material, thermoplastics, simulation-based.*

Life Cycle Cost and Replacement Analysis for Power Plant Generator

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Abstract. Life cycle cost is the overall costs that arise during ownership of an equipment, starting from purchasing, operating, maintaining, and including equipment's disposal. Whereas replacement analysis is a method used in order to compare the most economical alternative between equipment, which are called by defender and challenger. Life cycle cost and replacement analysis are important for the company to get the cheapest costs during the equipment life cycle. Generator is one of the main equipment in power plant, so its reliability and availability must be maintained to obtain the best performance of power plant. Due to high losses which is caused by the generator, it is necessary to conduct a feasibility study of the generator using life cycle cost and replacement analysis. Life cycle costs and replacement analysis will give best choice between two alternative. Alternative one is to keep the old equipment with the existing maintenance strategy, and alternative two is replace the equipment with the new one.

Keywords: *life cycle cost, replacement analysis, power plant generator*

Design Analysis in the Application of Solar Energy for Crossing River HDPE Boat

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Abstract. Solar energy become alternative in the provide power for many transportation modes. It is also growing fast in the sea transportation such as ship and boat. The lack of solar power is relatively low power output instead of the free in prices. In the other hand, to get higher power then such as energy sources need bigger plant area. Therefore, one of the solution that will be explore in this study is using lighter boat material such as HDPE to lowering draft and in consequently should lowering hull resistance. Combined latest solar cell technology and lightest HDPE material may present a better design in term of technical and economic aspects. A double impact for green earth campaign by a good combination of renewable energy and environmentally friendly materials. This work uses a 15 meter crossing river boat as case study. The proposed design analyzed to perform as many owner requirements as possible to serve in the certain crossing river area. Also there will be comparative study with the other ship material commonly used such as fiberglass and aluminum.

Keywords: *solar energy, boat design, HDPE material, crossing river boat*

Multi-Response Optimization of Vibration and Surface Roughness on the Surface Grinding Process Parameter Using OCR12VM Material With Taguchi-Grey Method

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Abstract. Grinding is a machining process that utilizes abrasive powder in the form of a wheel at high-speed rotation to cut the workpiece surface, so that it requires the right combination of process parameters to get a low vibration value and the appropriate level of surface roughness. The purpose of this study is to analyze the effect of Wheel speed 1500, 2000, 2500, 3000 (rpm), Tangential speed 11, 92, 173, and 256 (mm/s), and Cross feed 5, and 15 (mm/stroke) on vibration and surface roughness. This study used Taguchi method L32 (2^1 x 4^2) for experimental design with variations in 4 level of wheel speed, 4 levels of tangential speed, and 2 levels of cross feed. Furthermore, the grey relational analysis method (GRA) combined with Taguchi was used to optimize the multi-response characteristics of the experimental results. The specimen material used is OCR12VM hardened tool steel of 58 HRC with dimensions of L 300 mm x W 60 mm x H 30 mm. The machine tools of KRISBOW KGS818AHD is used to grind the workpiece surface by using Aluminum oxide grinding wheel. The results shows the contribution of factors in reducing the variation of the responses observed simultaneously, respectively, cross feed 37,17 %, tangential speed 29,94 % and wheel speed 20,90 %. The optimization results have been validated in the confirmation experiment. The optimum response process parameters, are the cross feed of 5 mm/stroke, tangential speed of 11 mm/s and wheel speed of 3000 (rpm).

Keywords: g*rey relationalanalysis, surface grindig, taguchi*

Influence of Test Piece Geometry to the Plastic Deformation of Balloon Expandable Stent

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Abstract. Considering the raw material of balloon-expandable stent that usually obtained from tube-type geometry, it is still unclear how the multilinear isotropic model obtained from flat-type test piece can be used to represent the actual behavior of stent expansion. In this experimental study, non-standard sheet-type and tube-type tensile test specimens are prepared, which are made from stainless steel 316L. The geometry of sheet-type and tube-type specimens for the tensile test. To assure equality of both chemical composition, the testing is carried out using Optical Emission Spectrometer. All type of specimen undergoes tensile test up to permanent failure. For the tube-shaped (axial and tangential), three pieces of specimens are prepared for the tensile test. The stresses and strains are recorded in order to generate stress-strain relationship and then compiled for analysis. The study indicated that the correlation between the stresses and the strains was not similar among those geometry of specimens. Tangential specimen experienced increasing of strain faster than that of stress. It differed significantly compared to the sheet-type specimen. A moderate correlation between the stress and the strain is obtained by the tube-shaped axial specimen. To verify the existed tendency, it is necessary to identify the plastic deformation on the specimens using numerical study.

Keywords: *balloon-expandable stent, tensile property, tube-shaped specimen*

Assembly Line Design in Final Assembly Excavator at PT.XYZ Using Genetic Algorithm

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Abstract. Large scale manufacturing companies are growing along with the ever-increasing demand from consumers, one of which is the heavy equipment industry. Excavators are the products of the heavy equipment division at PT. XYZ, Excavator assembly lines are single-model. Based on observations of existing conditions that occur at PT. XYZ, the production still cannot meet the demands of consumers. In the assembly process, the Excavator has a significant time difference from each work station, it can be said that the distribution of work elements in the assembly process is uneven. In the Final assembly section (Zone C) there is a discrepancy between the takt time of Excavator products which is one reason for not achieving demand. In resolving these problems, a trajectory balancing process is needed, namely balancing workloads on each workstation. This study applies the Heuristic Priority Rules method as an initial solution and as input from the Genetic Algorithms method to complete line balancing with a single-model system. Problems can be solved by increasing line efficiency from existing conditions by 60.4% to 91.74% and Smoothness index which decreases from 955.54 to 158.3977. The proposed result of balancing the final assembly of the excavator results in a better balance of assembly lines.

Keywords: *assembly line, line balancing, genetic algoritm*

Surface Roughness Characterization of Medical Implant Material SS316L Stainless Steel After Cut With Water Jet Cutting Process

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Abstract. In this paper, effect of water jet cutting process on the surface character of medical implant SS316L was investigated. This research focus in the effect of traverse speed during abrasive water jet cutting on the surface roughness and to-pography of medical implant material SS316L. In some study it has been noted that the roughness of implant material has correlation with healing process. Furthermore, transverse speed has important role in the manufacturing process that correlate directly with the ability of a technic to produce a number of product in definite time. Garnet was used as abrasive material in this water jet cutting process. The process was take place in room temperature with 3000Psi of water pressure. The surface roughness was measured across of depth of cut in all of transverse speed using Mitutyo SJ 210, while the surface topography observed by Olympus BX53M optical microscope. The experimental results show that traverse speed has great effect on the surface roughness at the surface, middle, and bottom of the cut point. The Surface roughness increase as transverse speed

Keywords: *Abrasive Water Jet Cutting, SS316L, Surface Roughness, Implant Material*

Surface Roughness Evolution and Dimensional Changes of Magnesium Alloy Plate during Electropolishing

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Abstract. Surface roughness has been considered as one of the most critically important parameters which determine degradation rates of magnesium (Mg) based biomedical implants. An appropriate surface finishing should therefore be carried out to obtain implants with a roughness that will lead to the desired degradation rates. In this research, electropolishing is conducted for a surface finish of machined AZ31B Mg alloy plate. The evolution of surface roughness and dimensional changes of this plate during the electropolishing were then studied. The results shows that the electropolishing for 30 min decreased the roughness of Mg alloy plate from Ra = 3.92 □m to 2.32 □m. Meanwhile, the width and thickness of the plate reduced up to 6% and 25%, respectively, but the hole of the plate increased by ~13% with the electropolishing for 30 min. In addition, a series of electron micrographs was presented to indicate the changes in surface morphology of the alloy due to the electropolishing. Based on the results in this study, it can be concluded that electropolishing is a promising technique for surface finishing of Mg based implants, but it should be well controlled to anticipate dimensional changes on the treated materials.

Keywords: E*lectropolishing, Magnesium Alloy, Surface, Dimensional Changes*

The Combination Effect of Machine Dynamic Behavior, Laser Power and Scan Speed on the Accuracy of Single Layer Bead Corner Formation in the Selective Laser Melting

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Abstract. The accuracy of the products of 3D printers is a very important parameter. Many parameters that affect this accuracy, such as staircase effects, support effects, radius effects, offset and curved boundary effects, slicing and swelling effects, properties and dynamic behavior of machine drives. This study looks for the relationship between the radius effect and dynamic characteristics of 3D printer machines with Selective Laser Melting technology on the accuracy of corner formation. As the research material, PLA powder is spread and leveled on a glass substrate to form a single layer of PLA powder with a thickness of 0.9 mm. In the process of forming objects that have an angle of 90o, theoretically the tip will have a curvature radius equal to the radius of the laser beam. However, due to the occurrence of a melt that is wider than the laser beam, the fillet radius that occurs will be greater. In right angle formation, 2 motion mechanisms are needed, the first motion mechanism towards the x axis then stops in one position and the second motion mechanism towards the y axis. This is the process of acceleration and deceleration of the two mechanisms. As a result of the start and stop process this will also affect the shape of the formed fillet. To find out the shape that occurs when the laser position stops, four specimens are made by giving a laser power of 8, 12, 16 and 20 Watt respectively with a very short time. From the measurement of the results of melt in the form of dots, it turns out that the point diameter that occurs is an average of 2.05 mm and is not affected by the amount of laser power. Furthermore, specimens were made in the form of four 50 mm lines with a speed of 16 mm / s and laser power of 8, 12, 16 and 16 Watt respectively. The tip curvature radius at start and stop is almost the same as 1.1 mm. The size of the curvature radius at start and stop turns out to be the same as the point radius that occurs in the point formation experiment, so the curvature radius when forming the right angle is predicted to be 1.1 mm and not affected by the magnitude of the laser power. This is evident from the formation of a 90o angle specimen, i.e. the fillet radius that occurs is 1.1 mm.

Keywords: *Selective Laser Melting, Machine Dynamic Behavior, laser power, Scan Speed, Corner Accuracy*

The Combination Effect of Machine Dynamic Behavior, Laser Power and Scan Speed on the Accuracy of Single Layer Bead Corner Formation in the Selective Laser Melting

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Abstract. The accuracy of the products of 3D printers is a very important parameter. Many parameters that affect this accuracy, such as staircase effects, support effects, radius effects, offset and curved boundary effects, slicing and swelling effects, properties and dynamic behavior of machine drives. This study looks for the relationship between the radius effect and dynamic characteristics of 3D printer machines with Selective Laser Melting technology on the accuracy of corner formation. As the research material, PLA powder is spread and leveled on a glass substrate to form a single layer of PLA powder with a thickness of 0.9 mm. In the process of forming objects that have an angle of 90º, theoretically the tip will have a curvature radius equal to the radius of the laser beam. However, due to the occurrence of a melt that is wider than the laser beam, the fillet radius that occurs will be greater. In right angle formation, 2 motion mechanisms are needed, the first motion mechanism towards the x axis then stops in one position and the second motion mechanism towards the y axis. This is the process of acceleration and deceleration of the two mechanisms. As a result of the start and stop process this will also affect the shape of the formed fillet. To find out the shape that occurs when the laser position stops, four specimens are made by giving a laser power of 8, 12, 16 and 20 Watt respectively with a very short time. From the measurement of the results of melt in the form of dots, it turns out that the point diameter that occurs is an average of 2.05 mm and is not affected by the amount of laser power. Furthermore, specimens were made in the form of four 50 mm lines with a speed of 16 mm / s and laser power of 8, 12, 16 and 16 Watt respectively. The tip curvature radius at start and stop is almost the same as 1.1 mm. The size of the curvature radius at start and stop turns out to be the same as the point radius that occurs in the point formation experiment, so the curvature radius when forming the right angle is predicted to be 1.1 mm and not affected by the magnitude of the laser power. This is evident from the formation of a 90o angle specimen, i.e. the fillet radius that occurs is 1.1 mm.

Keywords: *Selective Laser Melting, Machine Dynamic Behavior, Laser Power, Scan Speed, Corner Accuracy*

Replacement Scheduling of Brine Heater Desalination Plant Using Binary Integer Programming Method

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Abstract. Every equipment, both main and supporting, in electricity generation, has an economic life. An increase age of assets will followed by an increase of operating and maintenance costs. It is therefore very important to carry out a systematic, integrated, and comprehensive long-term planning by conducting economic evaluation modeling on the condition of the equipment in order that the optimum action plan can be selected. In the existing condition the decision about the replacement of equipment is based on the inability of the equipment to function, without taking into account the increase of operating and maintenance costs that have been incurred. A binary integer programming mathematical program is used to model decision making to find the most optimal replacement policy to generate maximum profits, taking into account the value of income, operating and maintenance costs, salvage value and investment cost. Replacement policy for four years is given as an example. The model will be implemented to determine a policy of replacing or keeping the Desalination Plant part with the aim of producing maximum profits.

Keywords: *Electricity Generation, Desalination Plant, Replacement policy, Binary Integer Programming*

Numerical Structure Analysis of Air Purifier Bike with Frame Designs and Materials Variation

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Abstract. The design and manufacture of air purifier bike for city residents in this case is an effort of the research team to contribute to the community in terms of reducing urban air pollution as a result of the increasing number of motorized vehicles on the roads as well as the growing of industrial activities that are rapidly increasing. The effect of motor vehicle exhaust gases on the road has caused a serious decline in the health of city residents. Based on previous experience regarding the design and prototype of tandem bicycles, both the tandem connector and the sliding tandem bike, as well as analyzing the airflow for cooling the room, the research team carried out the design and manufacture of air purifier bike (APB). Exploration of the design and material of the APB frame is carried out to obtain the best possible illustration frame design for realization them. Numerical analysis of the structure carried out includes observations of changes in frame design, wall thickness and diameter as well as pipe material. Information about the stresses and strains that occur at the APB frame for various variables will be obtained which will then guide the designer to design, prototype and development of the APB.

Keywords: *numerical, structural analysis, air purifier bike, frame design, material*

The Effect of Processing Parameter on Composite's Impact Strength of Continuous Unidirectional Polypropylene-Glass Fiber Composite

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Abstract. Polypropylene-Glass fiber composite is one of the cost-effective material in engineering application. Further knowledge on how extrusion processing parameter variable could affect the mechanical properties of the composite can give an insight to understand one of the many factors determining mechanical properties of composite material. This study aims to find correlation between impact strength of polypropylene-glass fiber composite with processing parameters of injection molding process namely temperature and injection pressure.

Keywords: *polypropylene, glass fiber, composite, extrusion, injection molding*

Macro-micro Analyses on 2-layer Semiautomatic MIG Welding of AA5052 Material Using ER5356 Electrode

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Abstract. Lightweight structures have widely been used due to their weight saving. Aluminum alloys are among the alternative for their material, and they are mostly manufactured by employing welding process using the same filler material as the base metal. Aluminum welding process can be conducted employing 2-layer semiautomatic MIG when the thickness of the plate is no more than 5 mm. Porosity in aluminum alloy welding is considerably difficult to avoid due to hydrogen and oxygen environment. Macro-micro analyses on 2-layer semiautomatic MIG welding of AA5052 material using ER5356 electrode have been carried out. A pair of AA5052 plates of 400 mm 75 mm 5 mm were clamped at three points of one side and welded using 2-layer semiautomatic MIG welding using ER5356 filler such that angular distortion can happen. Welding speed of 6, 7, and 8 mm/s using electrical voltage of 23 Volt, current of 130 Ampere, filler diameter of 0.8 mm, and shielded using argon gas. After completion of the welding, angular distortion was measured using dial indicator possessing accuracy of 0.01 mm. Welding result was micro-Vickers (VHN0.1) hardness, tension and Charpy impact, as well as microstructure using OM and SEM-EDS. The highest tensile strength was found at welding speed of 7 mm/s, angular distortion of 6.78^0, average VHN0.1 of the BM, HAZ, and WM of 47.82, 49.14, and 51.75, respectively. Tensile strength of 156.5 MPa and joint efficiency of 70%, BM failure strain of 17%, Charpy impact of 0.26 J/mm2. SEM-EDX at spot shows that the amount of Mg is not significant for being Al2Mg3 precipitate such that Vickers hardness distribution do not show any difference among BM, HAZ, and WM.

Keywords: *AA5052, ER5356, macro-micro analysis, MIG welding, semiautomatic*

The Effect of Suction Pressure of Vacuum Clamping on the Result of Aluminum Plate Cutting Process using Mini PC-Based CNC Milling

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Abstract. Gripping equipment needs of plate cutting process using PC-Based CNC milling for robotic component production have produced an active gripping equipment which is vacuum clamping. The advantages of this gripping equipment are the capability to grip thin workpieces such as plate, only having one gripping surface (bottom part), and able to grip workpieces which could not gripped by magnetic clamp (such as non-ferrous metal, and wood). Vacuum clamping gripping equipment relies on suction pressure as gripper of workpieces to be processed, hence the working pressure of gripping the workpieces should be studied to get the best surface of cutting process. Aluminum plate cutting process equipment were used PC-based CNC milling equipment with vacuum clamping as gripping equipment, cuter end mill HSS with diameter 3 mm, aluminum plate (Al 1100¬) with thickness 1.7 mm as workpieces. The sealing was used rubber mat with thickness 1.7 mm. The milling process used spindle rotation speed 2650 rpm, with feeding 32 mm/minute and cutting depth 0.2 mm. Surface roughness of cutting process product was measured by Profilometer. Suction pressure of vacuum pump was controlled by valve and control tube so the suction pressure was stable during machinery process, with suction pressure variation -18 inHg, -20 inHg, -22 inHg, and -24 inHg. The aim of the study are to observe the capability of vacuum clamping as gripping equipment for aluminum plate cutting process using PC-based CNC milling equipment, to get the optimum suction pressure of vacuum clamping, and the effect against surface roughness for aluminum plate cutting process. The result of the study show that aluminum plate cutting process using vacuum clamping as gripping equipment with suction pressure -24 inHg, and -22 inHg is able to produce surface roughness (Ra) which is still within the limit standard of DIN 4768 part 2.

Keywords: *gripping, vacuum, clamping, cutting*

Waste Analysis to Improve Container Port Performance Using Lean Six Sigma Method

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Abstract. One of the container port performance is the ratio of Effective Time to Berth Time (ET:BT). A thorough study of the loading and unloading process is required to improve it. Data obtained were analyzed by using Big Picture Mapping (BPM) followed by Process Activity Mapping (PAM). Activities that categorized to be non-value added (NVA) are examined in detail using the Root Cause Analysis (RCA) method and 5 Why's Analysis. Results obtained are several factors that cause waste. These factors, then, would be reviewed to produce four classification of improvement recommendations namely scheduling, management, human error and tools/facilities.

Keywords: -

Influence of Specimen Geometry to the Tensile Test Property of 316 L Stainless Steel: Study Case on Raw Material of Stents

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Abstract. Considering the raw material of balloon-expandable stent that usually obtained from tube-type geometry, it is still unclear how the multilinear isotropic model obtained from flat-type test piece can be used to represent the actual behavior of stent expansion. In this experimental study, non-standard sheet-type and tube-type tensile test specimens are prepared, which are made from stainless steel 316L. The geometry of sheet-type and tube-type specimens for the tensile test. To assure equality of both chemical composition, the testing is carried out using Optical Emission Spectrometer. All type of specimen undergoes tensile test up to permanent failure. For the tube-shaped (axial and tangential), three pieces of specimens are prepared for the tensile test. The stresses and strains are recorded in order to generate stress-strain relationship and then compiled for analysis. The study indicated that the correlation between the stresses and the strains was not similar among those geometry of specimens. Tangential specimen experienced increasing of strain faster than that of stress. It differed significantly compared to the sheet-type specimen. A moderate correlation between the stress and the strain is obtained by the tube-shaped axial specimen. To verify the existed tendency, it is necessary to identify the plastic deformation on the specimens using numerical study.

Keywords: *balloon – expandable stent, tensile property, tube – shaped specimen.*