

# **6th International E-Conference on Industrial, Mechanical, Electrical and Chemical Engineering (ICIMECE 2020)**

Towards the Development of Intelligent Green  
Technology to Contribute High Energy Efficiency  
with Low Environment Impact

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**IOP Conference Series: Materials Science and Engineering**  
Volume 1096

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## The 6<sup>th</sup> International Conference on Industrial, Mechanical, Electrical and Chemical Engineering – ICIMECE 2020

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# The 6<sup>th</sup> International Conference on Industrial, Mechanical, Electrical and Chemical Engineering – ICIMECE 2020

October 20<sup>th</sup>, Surakarta, Indonesia

Peer reviewed papers from The 6<sup>th</sup> International Conference on Industrial, Mechanical, Electrical and Chemical Engineering – ICIMECE 2020

Edited by:

Dominicus Danardono Dwi Prija **Tjahjana**

Indri **Yaningsih**

Ubaidillah **Ubaidillah**

Muh. **Hisjam**

Miftahul **Anwar**

Sperisa **Distantina**



## Preface

The 6th International Conference on Industrial, Mechanical, Electrical, and Chemical Engineering – ICIMECE 2020, was organized by the Faculty of Engineering, Universitas Sebelas Maret, on October 20th, 2020. This year we also collaborate with one big event held by Pembangkit Jawa Bali (PJB) called PJB connect, which also take a role as co-host of ICIMECE 2020. The Organisers of this event are located in the Faculty of Engineering, Universitas Sebelas Maret, Indonesia.

Since the COVID-19 Pandemic has raised significant health concerns worldwide, bringing on travel issue restriction and avoiding the face-to-face meeting that helps reduce the virus spreading, the ICIMECE 2020 was held in a virtual format using web streaming technology. This new format yet will not reduce our target to make ICIMECE 2020 as the forum for sharing and discussing the knowledge, experiences, and results of engineering, science and technology. Considering the contribution on Energy and Environmental Issue, the ICIMECE 2020 deciding the theme on “Towards the development of intelligent green technology to contribute high energy efficiency with low environmental impact”.

In term of data, ICIMECE 2020 received 243 submissions. After the rigorous peer reviewing process which was a single-blind peer-reviewed, 152 papers have been accepted for oral presentation in the conference. These papers are coming from 10 countries (USA, Netherlands, Estonia, China, Taiwan, South Korea, Japan, Vietnam, Malaysia and Indonesia). The conference session was held by using Youtube streaming technology for Keynote Speakers and by recorded presentation for Invited Speaker and participants. Zoom Webinar Technology at Faculty of Engineering, Universitas Sebelas Maret was used to deliver the Keynote speeches. During the Keynote session, 200 participants were joined in the Webinar. Five outstanding Keynote Speakers from Japan (2), South Korea (2), and Malaysia (1) were allocated to give 30 minutes presentation and 10 minutes for the Q&A session. The participants allowed to drop the question to the Keynote Speaker during the Keynote session. For the plenary session (Invited Speaker and Participants) the presentation time were 10 minutes and Q&A session was trough comment chat window provided by YouTube platform. The recorded video during the Keynote Session and Plenary Session was uploaded to ICIMECE 2020 YouTube channel ( <https://www.youtube.com/channel/UCdVm44RV0w8dAYQ2gVnNPew/playlists>). The ICIMECE 2020 program were successfully running using this online technology. As the achievement, six papers were awarded as the Best Paper in this conference.

We express huge appreciation to our International Advisory members, Keynote Speakers, Invited Speakers, Referees, Participants, and all Organising Committee members for their valuable effort and support, bringing their expertise and experience, which could create a successful program of ICIMECE 2020. We extend our gratitude and thanks to PJB for their essential role and all those involved in organizing the ICIMECE 2020. Besides, we also address thank to IOP Conference Series: Material Science and Engineering, which greatly facilitated the conference proceedings.

Prof. Dominicus Danardono Dwi Prija Tjahjana

Chairman of ICIMECE 2020 – Department of Mechanical Engineering, Universitas Sebelas Maret

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## Keynote Speakers

**Takahiko Miyazaki**, Professor, Kyushu University, Japan

*Potential of latent load removal by activated carbons for energy savings of air conditioning systems*

**Mohd Azizi Abdul Rahman**, Associate Professor, Advance Vehicle System Laboratory, Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Malaysia

*Personalized Gait Treatment using Passive Controllable Ankle Foot Orthosis*

**Hyunsoo Lee**, Professor, School of Industrial Engineering, Kumoh National Institute of Technology, South Korea

*New Trends for Smart Manufacturing in COVID-19 Era*

**Ilwhan Oh**, Professor, Kumoh National Institute of Technology, South Korea

*Integrated Photoelectrolysis of Water Implemented on Organic Metal Halide Perovskite Photoelectrode*

**Koichi Murata**, Professor, Nihon University, Japan

*An Education Program for Technopreneurship: Developing Kaizen Mind*

## Invited Speakers

**Nurhazimah Nazmi** , Associate Professor, Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia  
*Gait Event Detection using Machine Learning Approach*

**Nur Azmah bt Nordin**, Associate Professor, Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia  
*Kind of Magnetic Responsive Materials*

**Koji Enoki**, Associate Professor, The University of Electro-Communications, Japan  
*Correlation of Pressure Drop in the Sintered Fibrous Porous Tube with Permeability and Friction Coefficient*

**Kosaku Kurata**, Associate Professor, Kyushu University, Japan  
*Application of Low-intensity Electric Fields to Cancer Treatment*

**Koji Nakabayashi**, Assistant Professor, Kyushu University, Japan  
*Study on the Development of Carbon-coated Alumina Support for Hydrodemetallization*

**Cucuk Nur Rosyidi**, Professor, Universitas Sebelas Maret, Indonesia  
*A Framework of Integrated Sustainable Make or Buy Decision Model*

**Eko Prasetya Budiana**, Associate Professor, Universitas Sebelas Maret, Indonesia  
*Modeling of Droplet Coalescence using Radial Basis Function Method*

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

- **Type of peer review: Single-blind**
- **Conference submission management system: Google form**
- **Number of submissions received: 243**
- **Number of submissions sent for review: 243**
- **Number of submissions accepted: 152**
- **Acceptance Rate (Number of Submissions Accepted / Number of Submissions Received X 100): 62.6 %**
- **Average number of reviews per paper: 2.5**
- **Total number of reviewers involved: 97**
- **Any additional info on review process: The first screening for the review process was evaluating the topic of the manuscripts. Only manuscripts that meet our topic of interest will be reviewed. At least two reviewers assessed the manuscripts. The point to be reviewed was the Originality, Scientific Contributions, Potential Impact, Presentation Quality, Potential for the interest of the readers, and the ethical aspects (e.g., plagiarism, data fabrication, or any ethical misconduct). Each criterion has five scales of the evaluation, which was judged from very poor to excellent. The similarity check was determined using Turnitin Software by the Organizer at Universitas Sebelas Maret. To avoid the rejection, the similarity index must be less than 20% similarity. The review process results were decided by the overall recommendation with the criteria Accept, Minor Revision, Major Revision, or Reject. The decision for each manuscript were announced after receiving at least two statements from reviewers.**
- **Contact person for queries: Prof. Dominicus Danardono Dwi Prija Tjahjana; ddanardono@staff.uns.ac.id**



# Table of contents

Volume 1096

2021

◀ Previous issue    Next issue ▶

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Accepted papers received: 10 February 2021

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Potential of Latent Heat Load Removal by Activated Carbons for Energy Savings of Air Conditioning Systems

T Miyazaki, Chairunnisa, F. Miksik, K Thu, J Miyawaki, K Nakabayashi, A T Wijayanta, F Rahmawati, B Kristiawan and I Yaningsih

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Personalized Gait Treatment Using Passive Controllable Ankle Foot Orthosis

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K Kurata, T Iwata, K Shimada and H Takamatsu

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012004

## A Framework of Integrated Sustainable Make or Buy Decision Model

C N Rosyidi

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012005

## Correlation of Pressure Drop in the Sintered Fibrous Porous Tube with Permeability and Friction Coefficient

K Enoki, T Kobayashi, R Watanabe, Y Otomo, A Akisawa, I Yaningsih, B Kristiawan and A T Wijayanta

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D Rahmasari, W Sutopo and J M Rohani

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## Energy Efficiency Analysis in a Textile Company Using DMAIC Approach

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## Feasibility Study of Web-Based POS System Implementation for SMEs in Bangladesh

A I Sourav and A W R Emanuel

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## Performance of EWMA and ANN-based Schemes in Detection of Denial of Service Attack

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012010

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Equipment Replacement Analysis from Manual Line to Automatic Line in Palletizing Activities: A Case Study

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M W D Utami, A Ma'aram and M Hisjam

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E Kristiningrum and H Kusumo

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Network Characterization of Goods Movement in Indonesia

B M Sopha and A Setiawan

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Strategic Information Systems Planning for Higher Education in Uganda

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Improvement of Work Method with Eliminate, Combine, Re-arrange, and Simplify (ECRS) Concept in a Manufacturing Company: A Case Study

A K Nisa, M Hisjam and S A Helmi

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Realization of Noise Dosimeter Calibration Based on Percentage of Noise Dose Exposure using Absolute Method

B Dwisetoyo, D Rusjadi, M R Palupi, C C Putri, F B Utomo, N R Prasasti and D Hermawanto

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P A Wicaksono, S Saptadi, D Nurkertamanda and R Rozaq  
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A Cut-off Grade Optimization Model in Multi Product Open Pit Mining Considering Reclamation and Valuable Waste Materials  
R Novitasari, C N Rosyidi and A Aisyati  
[+ Open abstract](#) [View article](#) [PDF](#)
- 
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Development of an Electronic Reverse Logistics Network Model: A Literature Review  
D P Sari, N A Masruroh and A M S Aasih  
[+ Open abstract](#) [View article](#) [PDF](#)
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A Cut-Off Grade Optimization Model in Open Pit Mining Considering Reclamation Cost and Revenue  
N Baidowi, C N Rosyidi and A Aisyati  
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An Optimization Model of Nurse Scheduling Using Goal Programming Method: A Case Study  
Meidi Putri Ariyani, Cucuk Nur Rosyidi and Azizah Aisyati  
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Optimization Model for Determining Order Quantity for Growing Item Considering Incremental Discount and Imperfect Quality  
L Luluah, C N Rosyidi and A Aisyati  
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A Truck Allocation Optimization Model in Open Pit Mining to Minimize Investment and Transportation Costs  
M F Isnafitri, C N Rosyidi and A Aisyati  
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## Development Models of Personality, Social Cognitive, and Safety Culture to Work Accidents in the Chemical Company

R N Sari and D S Dewi

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## Redesign of Facilities Layout Using Systematic Layout Planning (SLP) on Manufacturing Company: A Case Study

A T Haryanto, M Hisjam and W K Yew

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## Mini Review on Eddy Current Brakes Parameter

M R A Putra, M Nizam, D D D P Tjahjana and A R Prabowo

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## Design a Mechatronic System (Robot) to Transfer Table Tennis Balls

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## Collaborative Robot Safety for Human-Robot Interaction in Domestic Simulated Environments

T E Kaonain, M A A Rahman, M H M Ariff, W J Yahya and K Mondal

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## Design of Fishing Vessel 5 GT for Traditional Fishing Community Activities

S F Khristyson, Jamari and A P Bayuseno

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## The Influence of Zalacca Short-Fiber Addition with Random Orientation on the Characteristics of Low-density Polyethylene Matriced Composites

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## Design of Kaplan-Series Propeller for Commercial Submarine by Varying Rake Angle and Number of the Blade to Obtain the Highest Thrust and Efficiency

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## Numerical Simulation of Long Duration Sloshing Using Smoothed Particle Hydrodynamics

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## Design of Hug Machine Portable Seat for Autistic Children in Public Transport Application

I Y Afif, M I Maula, M B Aliyafi, A L Aji, T I Winarni and J Jamari

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012035

## Simulation of Thermal Dispersion in Location of Development of Diesel Power Plant Using Computational Fluid Dynamics Methods

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## Characterization of Calcium Hydroxide-treated Zalacca Fibers for Improving Properties as Reinforcement for Composites

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## Development of Utilization Alkali-Treated Bamboo Fiber as a Strengthener in Thermoset and Thermoplastic Composites

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## Utilization of Bamboo Fiber in the Development of Environmentally Friendly Composite – A Review

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## Parameters of Savonius Type Hydrokinetic Turbine to Enhance Efficiency

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## The Characteristics of LPG Detonation Wave Propagation Behind Porous Media Model

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## A Numerical Ventilation Problem on Fridsma Hull Form Using an Overset Grid System

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## The Effect of T6 Heat Treatment on 7075 Aluminum on its Hardness and Tensile Strength

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## Experimental Performance of A Rotary Desiccant Wheel Without Honeycomb Matrix Structure: A Preliminary Study

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012044

## Determining Water Content of Non-Surfactant Emulsion Fuel Using Bomb-Calorimeter

D A Sugeng, M Abrori, A Syafrinaldy, H A Kadir, F R Saputro, B H Kusdi, I Bahiudddin and W J Yahya

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012045

## Recent Progress of Fused Deposition Modeling (FDM) 3D Printing: Constructions, Parameters and Processings

G Prayitno, F Imaduddin, Ubaidillah and Z Arifin

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012046

## Magnetorheological Fluid Yield Stress Prediction Using Particle Swarm Optimization at Low and High Shear Rate Region

F Bahudin, F Imaduddin, S A Mazlan, M I Saphira and A A Isman

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**D Widjanarko, R D Kusumaningtyas and I P Jamari**

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**The Effect of Copper-Aluminium Perforated Heat Sink to Improve Solar Cell Performance**

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012049

**Application of Elliptical Blade Shape to Enhance Power Generation of the Savonius Water Turbine**

A Sutaji, M Yusvika, D D D P Tjahjana and S Hadi

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**Prediction of the Hydrodynamic Performance of an Elliptical Blade Savonius Turbine using Computational Fluid Dynamics**

M Yusvika, A Sutaji, A R Prabowo, F Imaduddin and S Hadi

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**Photovoltaic Performance with Heat Sink from Copper and Aluminum Material**

A Maulana, R A Rachmanto, S Hadi and Z Arifin

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**Analysis of TiO<sub>2</sub>/Water-based Photovoltaic Thermal (PV/T) Collector to Improve Solar Cell Performance**

A F Fadli, B Kristiawan, Suyitno and Z Arifin.

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### Numerical Analysis of Heat Transfer Improvement in Flat Tube Car Radiator by Using TiO<sub>2</sub>/Water Nanofluids

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### Noise Quality and Muffler Design of A Formula SAE Racecar

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### Strategy and Master Plan for Water Supply and Domestic Wastewater in Klungkung Regency, Bali

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### Investigation of Ecohouse through CFD Simulation

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### Design Low Cost and Contactless Temperature Measurement Gate Based on the Internet of Things (IoT)

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# Effect of *Ceiba pentandra* Biodiesel/Dexlite Diesel Blends on the Four-Stroke Diesel Engine Performances

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**Abstract.** The increasing number of motorized vehicles causes an increase in fuel consumption. Meanwhile, fuel consumption in Indonesia is inversely proportional to the amount of oil production in Indonesia. One of the solution in by using biodiesel from kapok (*Ceiba pentandra*) seed as a diesel fuel blends. In this research, blends of dexlite (diesel fuel)/*Ceiba pentandra* biodiesel was studied on the four stroke diesel engine performance. Four different fuel blends (B10, B20, B30 and B40) and B0 (pure dexlite fuel) were prepared for the engine performance test. The engine performance shows that addition of biodiesel to diesel fuel gave lower torque than the dexlite fuel. Biodiesel blends also have lower brake power compared to the dexlite fuel. Among different biodiesel blends, A 10% biodiesel blend shows the best engine performance in terms of engine torque and brake power.

## 1. Introduction

Recently, major utilization of fossil fuel in the world became a concern to find an alternative fuel due to its environmental impact and the diminishing of its reserves. Biodiesel is considered as an alternative energy source in view of it is renewable, harmless, safe and biodegradable. More than 95% of biodiesel in the world is produced from edible oils since they have high biodiesel yield and easily processed due to their low free fatty acid [1]. In recent times, the demand for edible vegetable oil has increased and there are concerns such as high cost and negative impact on food chain [2]. There are several sources of non-edible oils that can be used for biodiesel production such as *Jatropha carcus*, *Pongamia pinnata*, *Callophyllum inophyllum*, rubber seed, *Azadirachta indica*, *Madhucha indica*, *Simmondsia chinensis*, *Ceiba pentandra* and microalgae [2]. Kapok (*Ceiba pentandra*) seed oil is among the prospective non edible oil for biodiesel synthesis.

*Ceiba pentandra* or locally known as kapok can be easily found in tropical countries such as Indonesia, Malaysia, Philipines, several parts of America and Africa [3]. Generally, *C. Pentandra* fibers are used as a stuffing material for beds, pillows, upholstery and substitute for absorbent cotton in surgery [1]. *C. Pentandra* seed has higher oil yields (26.4 wt.%) compared to edible oil such as soybean (18-22 %). Due to this properties, it makes *C. Pentandra* become a promising non-edible oil source for biodiesel production [4,5].

Transesterification is a conventional method to produce biodiesel from vegetable oils. This reaction usually reaches equilibrium state slowly, leading to a low conversion and high energy consumption





[6]. Kusumaningtyas et al. had utilized an enhanced batch reactor for producing biodiesel from kapok seed oil. It was found that it has an optimum biodiesel yield at 99.82%, which was obtained at the operating condition of: oil to methanol molar ratio of 1:6, reaction temperature of 60°C, catalyst concentration of 0.5%, and ultrasonic frequency of 28 kHz for 60 minutes reaction time. The biodiesel yield was found to be higher compared to the yield obtained from conventional process 91 - 97% [1,7,8]. It is reported that the feedstock blends could improve the fuel properties [9]. In this paper, *C. Pentandra* is blended with dextrite a diesel fuel produced by Indonesia oil and gas company PT. Pertamina. Dextrite has a minimum cetane number of 51 and a maximum sulphur content of 1,200 parts per million (ppm). It also contains 20% Fatty Acid Methyl Ester (FAME) [10].

From the previous studies, it was found that an addition of B20 into diesel fuel can increase the engine performance. However, a higher biodiesel blends composition decrease the engine performance. While an SO<sub>2</sub> emissions, CO and NO<sub>x</sub> particles, decrease constantly with the increasing of biodiesel content in the fuel blends [11,12]. Another study also stated that the emissions of CO, CO<sub>2</sub>, and HC from diesel fuel are higher than the emissions produced by biodiesel blends [13]. Recently, the diesel engine performance such as engine torque, brake power, brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature and the emissions was tested by using biodiesel obtained by using a conventional method [1,14–16].

In this study, various ratios of *Ceiba pentandra* biodiesel/diesel blends were used to investigate the four stroke engine performances (engine torque and brake power). The biodiesel *Ceiba pentandra* biodiesel was produced through ultrasound-enhanced transesterification reaction [17].

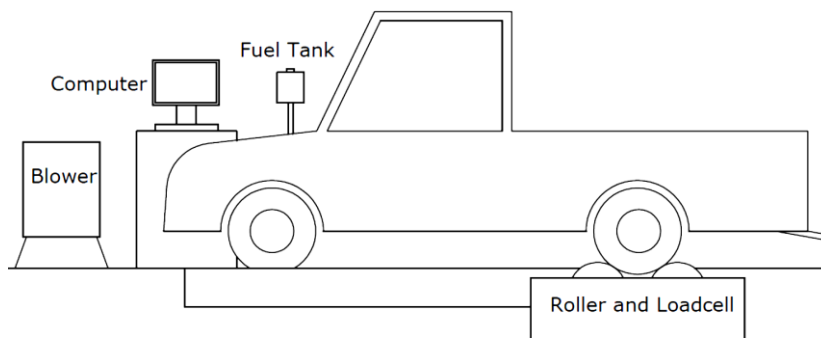
## 2. Materials and Methods

### 2.1. Materials

In this research, dextrite fuel was obtained from the Indonesian oil and gas corporation (PT. Pertamina). *C. Pentandra* biodiesel oil was produced in Chemical Engineering laboratory of Universitas Negeri Semarang by following the methods from previous studies [17]. Optimum operating condition was used in the biodiesel production.

### 2.2. Methods

First, biodiesel and diesel fuel was analyzed its physicochemical properties at the Laboratory of Natural Oil, Gas and Coal Technology, Universitas Gadjah Mada. The fuel used in this study is varied at four different volume basic ratios which are 10% (B10), 20% (B20), 30% (B30) and 40% B(40). A pure dextrite fuel was also prepared as a controlled variable with 0% additional of biodiesel (B0). The engine tests were performed at Mechanical Engineering of Universitas Negeri Semarang by using Dynamometer pull type LPS 3000 and four stroke diesel engine. A schematic of the experimental setup for diesel engine performance test can be seen in Figure 1. The performance test was aimed to measure the engine torque and engine brake power.



**Figure 1.** Schematic experimental setup for engine performance test.

The diesel engine used for this research is a diesel engine on an Isuzu Panther vehicle 2015. The specifications of the vehicle used are: MSG5K engine; 2,499 cc cylinder capacity; with maximum power of 80 PS / 3,500 rpm; maximum torque of 19.5 kgm / 1,800 rpm; number of cylinders: 4 in line; diameter x stroke 95.4 mm x 87.4 mm; and has 5 speed transmission.

Data obtained from the roller and load cell of dynamometers as shown in Figure 1 were processed and analyzed by using a computer system, so torque and diesel engine power of the tested vehicle can be produced.

### 3. Results and Discussion

#### 3.1. Characteristics of *Ceiba pentandra* Biodiesel/Diesel Fuel

The properties of dextrite and *Ceiba pentandra* biodiesel were measured at Chemical Engineering Laboratory of Universitas Negeri Semarang and Laboratory of Natural Oil, Gas and Coal Technology, Universitas Gadjah Mada. The detailed characteristics of biodiesel and dextrite are shown in Table 1.

**Table 1.** Properties of Dextrite diesel fuel and *Ceiba pentandra* Biodiesel.

Properties	Unit	<i>Ceiba pentandra</i> Biodiesel	Dextrite
Calorific Value	MJ/kg	39.74	44.45
Flash Point	°C	170	71
Density (40 °C)	g/ml	0.862	0.828
Kinematic viscosity (40 °C)	cSt	5.771	3.52

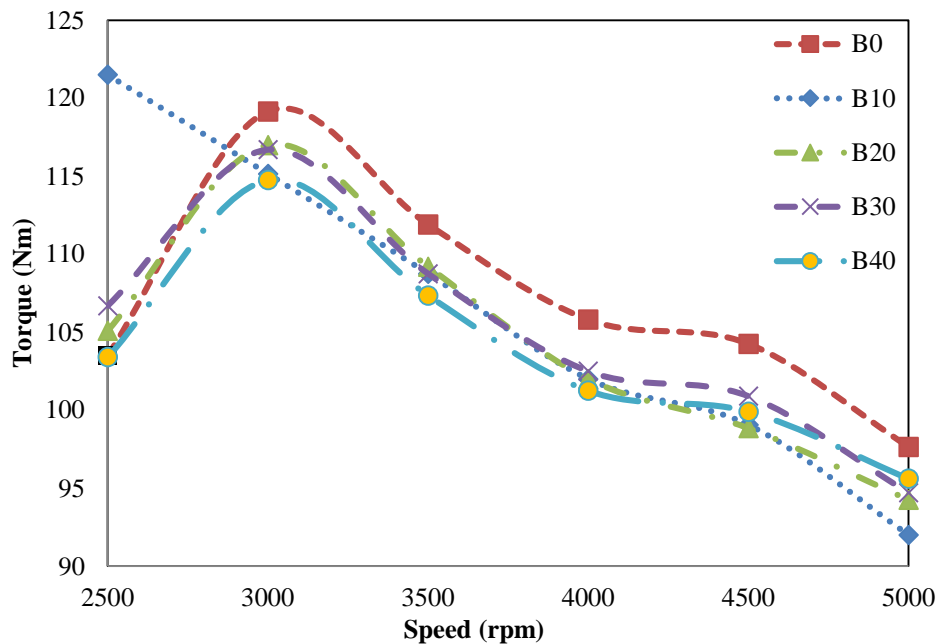
Generally, *C. pentandra* Biodiesel characteristics were already fulfill the requirements of Indonesia national Standard Certified Products for biodiesel (SNI). The SNI Standard for biodiesel's calorific value, flash point, density and kinematic viscosity were 37 MJ/kg, 100 °C, 0.85 – 0.89 ml and 2.3 – 6.0 cSt. However, differences in the physic- chemical properties of biodiesel and diesel fuel make a difference in the basic properties of biodiesel blend which further affect the engine performance and emission [18].

The performance test in this study will measure the power and torque of diesel engine by using a different combination of diesel fuel with *C. Pentandra* Biodiesel. The combinations were B0 (100% Dextrite), B10 (blends of 90% Dextrite and 10% Biodiesel), B20 (blends of 80% Dextrite and 20% Biodiesel), B30 (blends of 70% Dextrite and 30% Biodiesel) and B40 (blends of 60% Dextrite and 40% Biodiesel).

#### 3.2. Effect of Biodiesel Blends on the Diesel Engine Torque

Figure 2. Shows the variations of engine torque with engine speed for various diesel fuel blends. It can be seen that pure dextrite (B0) have a greater torque compared to dextrite blends with *C. pentandra* biodiesel.

In general, maximum torque on diesel engine occurs from 2,000 rpm to 2,500 rpm, meanwhile in this research we found that the maximum engine torque was found at engine speed of 3,000 rpm. It can be concluded that the engine torque at 2,000 rpm well be lower that engine torque at 2,500 rpm. From Figure 2, it can be seen that the engine torque is shifted after an addition *C. Pentandra* biodiesel oil in the dextrite fuel. For the B10 diesel fuel, the torque is constantly decreasing from 121.5 Nm to 92 Nm. While, other diesel fuel torque variations is increasing at the speed of 3000 rpm and then it decreases continuously until the speed of 5000 rpm. B0 has the lowest torque at 2500 rpm with only 103.5 Nm. However, it has the largest torque with 119.15 Nm at 3000 rpm and constantly gave the highest torque for the rest engine speed. Low engine torque at the highest speed was caused by the increasing of frictional force. Engine torque also can be affected by the energy from fuel combustion, meanwhile the fuel combustion energy is depended on the fuel calorific value [19]. Since the diesel fuel is mixed with the *C. Pentandra* biodiesel oil which has lower calorific value, it might cause the blends calorific value is also decreasing.



**Figure 2.** Effects of engine speed to the engine torque for different diesel blends.

Calorific value is also affected by the fuel's density, which is inversely proportional to the density. At the same fuel volume, the calorific value is decreasing as the increasing density of the fuel. It is in line with the data shown in Table 1, where biodiesel has a higher density compared to dextlite. However, in this research specific fuel consumption test was not carried out since the throttle is used as the test variable.

Dextlite fuel (B0) has the highest average torque engine with 107.04 Nm followed by B10, B30, B20 and B40 with average torque engine of 106.40 Nm, 105.04 Nm, 104.4 Nm and 103.78 Nm respectively. It can be concluded that B10 torque engine performance is closed to the pure diesel engine performance with only 0.6% difference.

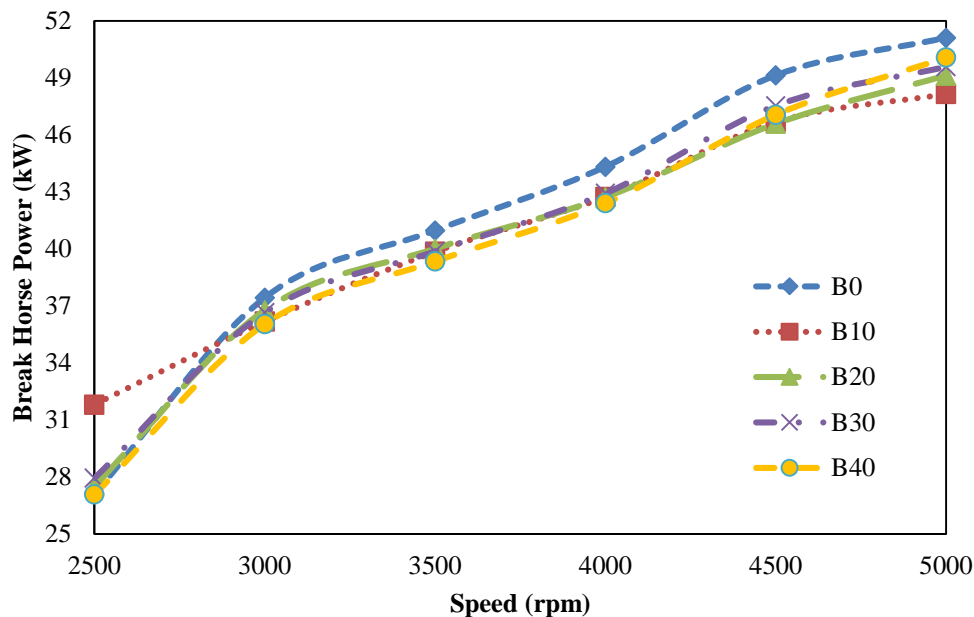
### 3.3. Effect of Dextlite Blends on the Diesel Break Horse Power

Figure 3 shows the effect variations of break horse power with engine speed for various biodiesel fuel blends.

From Figure 3, it can be seen that the addition of *C. Pentandra* biodiesel in the diesel fuel is not significant to the brake horse power. At 500 rpm, brake horse power of B0 is 51.11 kW, the brake power decreased to 48.15 with an addition of 10% *C. Pentandra* biodiesel. At the same speed, B20 and B30 output power is slightly higher than B10 which is 49.15 kW and 49.585 kW respectively. While, B40 has the largest output power among the blended diesel fuel with biodiesel, it gave an output power of 50.075 kW.

The brake horse power value of an engine is influenced by a frictional loss or also known as a mechanical friction loss. With the increasing of speed engine, it will increase the friction between piston ring and the cylinder. Operating a high speed engine with longer duration will decrease the mechanical power. Brake horse power also influenced by the viscosity of fuel. *C. Pentandra* biodiesel has a higher viscosity than dextlite fuel. Higher viscosity of the fuel can cover the cylinder, therefore the piston will have a smoother movement [20].

Based on the average value of the power output of the engine, B0 has the highest power among all the biodiesel blends with 41.678 kW. Meanwhile, the blend of dextlite with 10% of *C. Pentandra* biodiesel (B10) produces 40.889 kW and the result is in line with [19].



**Figure 3.** Effects of engine speed to the brake horse power for different diesel blends.

### Conclusion

An addition of *C. Pentandra* biodiesel to the diesel fuel affect the engine torque and the break horse power. From the performance test, B0 diesel fuel has generated the highest torque value. After adding a biodiesel in the fuel mixture B10, B20, B30, and B40 the torque produced is decreasing. The torque value is affected by the amount of energy generated from the combustion process. Meanwhile, the amount of energy is strongly influenced by the calorific value of the fuel. The decrease torque value is influenced by the calorific value of biodiesel, the calorific value of biodiesel fuel is smaller when compared to dextrite (B0) where the biodiesel calorific value is 39.74 MJ/kg and the calorific value of dextrite is 44.45 MJ/kg. Based on the average value of produced brake horse power, B0 generated the highest brake horse power. An addition of *C. Pentandra* oil decreases the power output. Compared to the produced torque, it is in accordance with the theory where the output power is influenced by the magnitude of the produced torque.

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# Certificate

This is to certify that  
**Effect of Ceiba pentandra Biodiesel/Dexlite Diesel Blends on the Four-Stroke Diesel Engine Performances**

Has been presented by  
**Dwi Widjanarko, Ratna Dewi Kusumaningtyas, Indoriana Putri Japari**

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