ISBN :

5th INTERNATIONAL CONFERENCE

FIRST

FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY (FIRST)

CONFERENCE PROGRAMS AND ABSTRACT

ADVANCING SUSTAINABLE SCIENCE AND TECHNOLOGY THROUGH EFFECTIVE COLLABORATION

OCTOBER 20-21, 2021

Palembang, Province of South Sumatera
Indonesia

Organized By :

FOREWORD FROM GENERAL CHAIR 5th FIRST 2021 INTERNATIONAL CONFERENCE

Assalamu'alaikum wr wb,

Alhamdulillahirrobbil 'alamin, Thank to the God, almighty, due to His bless and love, we are granted good health and opportunity so that we can meet here in the event of the 5th FIRST and the 3rd SNAPTEKMAS 2021.
The honorable keynote speakers of the 5th FIRST and the 3rd SNAPTEKMAS 2021

Dra. Nana Yuliana, MA., Ph.D., as The Indonesian LBBP Ambassador for the Republic of Cuba, concurrently with the Commonwealth of the Bahamas, Jamaica, the Dominican Republic and Haiti
Prof. Ramaraj Boopathy. from U Alcee Fortier Distinguished Service Professor of Biological Sciences At the Nicholls State University, USA
Dr. Ing. Ahmad Taqwa, the Director of State Polytechnic of Sriwijaya.

The honourable keynote speakers, distinguished guests, all participants, ladies and gentlemen,

For the beginning of my speech, let me welcome all of you with my great warm hug. It is a great honor for me that you choose the 5th FIRST and the 3rd SNAPTEKMAS 2021 as your conference. I am so proud that the authors still become enthusiastic to develop the knowledge although in this pandemic situation. Let us still work hard to support the development of the world through the research, science, and technology in many parts of the knowledge, as what has been purposed by the FIRST conference itself.

In this occasion, I would like proudly to inform you that the 5th FIRST and the 3rd SNAPTEKMAS 2021 as the forum to share knowledge, to search, to find, and to enlarge the link with other industries and universities has attracted so many authors from abroad, such as from: Politeknik Tun Syed Nasir Syed Ismail; MARA University; Politeknik Mukah Sarawak; University Sultan Zainal Abidin, Terengganu, Malaysia; Politeknik Melaka (PMK) Malaysia; Iloilo Science and Technology University (ISAT-U) Philipina; Politeknik Kota Kinabalu; Universiti Teknologi Malaysia; The National University of Malaysia; National Chin-Yi University of Technology (NCUT); Accounting Research Institute UiTM-Malaysia; Management and Science University Malaysia; AlBaha University, KSA, Saudi Arabia; Politeknik Melaka (PMK), Malaysia; Kuantan Community College, Pahang, Malaysia; Universiti Brunei Darussalam; and Ferdowsi University of Mashhad, Iran.

Welcome to all of the researchers that become the collaborators in our research and community service. It is our great honour to have you as our collaborators and participants in the 5th FIRST and the 3rd SNAPTEKMAS 2021.

The honourable keynote speakers, distinguished guests, all participants, ladies and gentlemen,

In this chance, I would like to say thank you very much to the Director of State Polytechnic of Sriwijaya for his full support in the development of the Research and Service Community programs. Due to his hard work and his belief to all of the committee so that this event can be held.

In this occasion, I also would like to convey my big thank to all of the keynote speakers, invited guests, all the participants, all reviewers, and all committee of the5th FIRST and the 3rd SNAPTEKMAS 2021. Without you all, this event will be nothing. May Allah SWT gives His reward for your sincerity. As the time goes by, it is hoped that our cooperation and coordination in the FIRST and SNAPTEKMAS can be maintained and improved. I hope that you can enjoy this conference and can get a big benefit from this event. I also wish that we can meet again in the forthcoming FISRT ad SNAPTEKMAS

Wassalamu'alaikumwaraahmatullahi wabarakatuh

FOREWORD FROM DIRECTOR OF STATE POLYTECHNIC OF SRIWIJAYA

The honorable, FIRST 2021 and SNAPTEKMAS 2021 keynote speakers,

Dra. Nana Yuliana, MA., Ph.D., as The Indonesian LBBP Ambassador for the Republic of Cuba, accredited to the Bahamas, Republic of Dominican, Republic of Haiti and Jamica

Prof. Ramaraj Boopathy., from U Alcee Fortier Distinguished Service Professor of biological sciences at the Nicholls State University, USA

Dr. Ing. Ahmad Taqwa, MT., as Director of Politeknik Negeri Sriwijaya

Assalamualaikum wr wb,

Let us extend our gratitude to Allah SWT, the most gracious, the most merciful. Due to His bless, we can gather here, at the Opening Ceremony of the FIRST 2021 and SNAPTEKMAS 2021

First of all, Please let me deliver my warm welcome to all keynote speakers and all participant of FIRST 2021 and SNAPTEKMAS 2021. It is my great pleasure to meet and see you in this event.

Although, there are so many obstacles that should be faced in the pandemic situation, however, as young generation, we should be optimistic, stay strong and be active in searching and finding the solution. The FIRST 2021 and SNAPTEKMAS 2021 as the DIES of State Polytechnic of Sriwijaya annual event will become one of the media to support those activities. The researchers could share knowledge, find partners, and enlarge the collaboration through this event.

Based on the change in the model of the teaching learning activity that focuses on the MERDEKA BELAJAR, State Polytechnic of Sriwijaya has a big desire in getting acceleration in the internationalization of the institution. One of them by improving the overseas and industrial collaboration, especially in joint research and joint publication. In the beginning of 2021, the research and community service unit in Politeknik Negeri Sriwijaya has launched new schemes of research and community service, namely the Overseas Collaboration Research and Overseas Collaboration Community Service. Thanks to God, those schemes have attracted researchers not only from Asia but also several other countries outside Asia, such as: research and community service collaboration with Al Baha University from Saudi Arabia, with Ferdowsi University of Mashhad from Iran, and with Princess Sumaya University of Technology from Jordan, as well as several other foreign universities.

In this occasion, I also would like to welcome all the researchers that become the collaborators in our new scheme of research and community service. It is our great honour to have you as our collaborators.

The honourable participants,

At this time, State Polytechnic of Sriwijaya has held 5 times of FIRST. FIRST publications from previous conferences have been successfully indexed not only in SCOPUS, but also in WOS. This 5th FIRST seminar will be conjugated with the 3rd National Seminar on Community Service SNAPTEKMAS. (National seminar of applied technology for public). All of these are the efforts to improve the quality of Polsri lecturers which significantly have a positive effect on the learning process of Polsri students.

Before ending my speech, I would like to congratulate the participants of The FIRST 2021 and SNAPTEKMAS 2021. May the noble efforts, support, and cooperation of researchers in this conference will continue. Special thanks to the organizer and co-organizer committee of The FIRST 2021 and SNAPTEKMAS 2021 for the hard work and the commitment in realizing this conference. Do maintain the spirit of working in a team and continue to unite in order to display a culture of excellence in the eyes of the country and the world.

With Bismillahirrahmanirrahim, I officiate The FIRST 2021 and SNAPTEKMAS 2021.
Wassalamu'alaikum warrahmatullahi Wabarakatu

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KEYNOTE SPEAKER

Prof. Ramaraj Boopathy

Alcee Fortier Distinguished Service Professor of biological sciences
at the Nicholls State University, USA

Fulbright Scholar Fulbright Senior Specialist World Class Professor-Government of Indonesia. Honorary Visiting Professor, ITB, Indonesia Alcee Fortier Distinguished Service Professor John Brady Endowed Professor in Biological Sciences Nicholls State University Business Address: Alcee Fortier Distinguished Service Professor John Brady Endowed Professor in Biological Sciences Department of Biological Sciences Nicholls State University Thibodaux **EDUCATION:** B.Sc. Zoology, University of Madras, India; 1979 M.Sc. Environmental Biology, Tamil Nadu Agricultural University, India; 1981 Ph.D. Environmental Biology, University of Madras, India; 1986 **UNIVERSITY RESPONSIBILITIES**: Responsibilities include Teaching Environmental Biotechnology, a Senior and Graduate lever course, Marine and Environmental Biology (Graduate Course), Microbiology and Environmental Biology courses. Research interests include Bioremediation of Hazardous Chemicals and Anaerobic Microbiology. Service includes advising students, participate in Departmental and University committees and serving the local and regional communities. Advisor to Masters Program in Marine and Environmental Biology. **PROFESSIONAL EXPERIENCE:** January 2013 – Present: John Brady Endowed Professor in Biological Sciences, Department of Biological Sciences, Nicholls State University, Thibodaux. Teaching, Research, and Service to the University and Community. August 2012 – Present: Alcee Fortier Distinguished Service Professor, Department of Biological Sciences, Nicholls State University, Thibodaux. Teaching, Research, and Service to the University and Community. August 2004 – Present: Distinguished Service Professor, Department of Biological Sciences, Nicholls State University, Thibodaux. Teaching, Research, and Service to the University and Community. **MAJOR AREAS OF RESEARCH INTERESTS:** Anaerobic digestion, Composting, Biodegradation of hazardous chemicals. Antibiotic resistant bacteria and Antibiotic resistance genes in the aquatic ecosystem. Isolation and identification of novel bacteria. Anaerobic degradation of explosive chemicals with particular reference to sulfate reducing bacteria. Design and development of biological reactor systems. Microbial immobilization of heavy metals and radionuclides. Alcohol production from agricultural residues. Water quality in the wetlands. Alternative to sugarcane burning, Biological control of termites. Organic ways to control land loss and coastal restoration.

KEYNOTE SPEAKER

Dr. Ing. Ahmad Taqwa, MT.

Director of Politeknik Negeri Sriwijaya Indonesia

Director of State Polytechnic of Sriwijaya, other than that, he is still active at Head of The Research and Publication Commission Forum Director of State Polytechnical In Indonesia, Founder of The Online Journalist Board (IWO) Sumsel, Chairman of The Advisory Board of UKM Nusantara Palembang and Assessor of Higher Accreditation Board. **EDUCATION**: Diplom Ingenieur Electrical Engineering HTL, Ingenieurschule Beider Basel, Switzerland; 1994,Magister (2005) and Doctoral (2010) at Electrical Engineering, Bandung Institute of Technology, Indonesia. **RESEARCH**: Head of Research Assignment “Mini PLTS Periodic Cooling System to Overcome Overheating in Palembang City” (2019), Member of The Research Assignment “Effects of Sea Salt Dust Collection on Output Loss and Solar Panel Output Efficiency” (2020), and Head of Research Assignment “Design and Build of Wireless Sensor Network Prototype Detection Of Landslides Based on IOT and LORA” (2020). **DEDICATION:** “The Design and Evaluation of Virus Scan in The E-Mail System in SMA N 5 Palembang” (2018), Assignment Service “Utilization of WSN Technology in Parking Air Monitoring Foundation SMP Harapan Mulia Palembang” (2019), Development of Teaching Materials with Interactive Multimedia with Education Game for Harapan Mulia Junior High School Students” (2020). **AWARD:** Certificate In Participating In The 200 Hour Advanced Technical Teacher Training awarded by FONTYS and PEDC (1998), Satyalancana Karya Satya X Year 2011 And Satyalancana Karya Satya XX Year 2017 by The President of The Republic of Indonesia. **WORKSHOP**: Seminar and Focus Group Discussion Forum The Rector of Indonesia “Economic Stability In The Vuca Area”, Ujung Pandang (2020), Workshop on Using Integrated Resources Information System Applications For Lecturers of State Polytechnical Polytechnic, Palembang (2019) And Workshop of Learning Methodology of Polsri Lecturers and Outside Education Domicile (PDD) as a Source Person, Palembang (2019).

RUNDOWN
The 5th FIRST 2021 INTERNATIONAL CONFERENCE
(FORUM IN RESEARCH SCIENCE AND TECHNOLOGY)
SNAPTEKMAS (Seminar Nasional Aplikasi Teknologi pada Masyarakat) 2021
Palembang, South Sumatera, Indonesia
Thursday, October 21, 20201

Thursday, October 21, 20201

No.	Session	Person in Charge	Time Allotment (WIB)	Liaison Officer
1.	Registration	Event Section Committee	07.00 – 08.00	Doeslohal Djumrianti, S.E.MIS., Ph.D
2.	The Opening Ceremony	Event Section Committee	08.00 – 09.00	
3.	Do'a			
4.	Indonesian National Anthem			
5.	Chair Report Speech			
6.	Speech and Opening Remarks by Director of State Polytechnic of Sriwijaya			
7.	Souvenirs Gift, Group Photos			

PLENARY SESSION

No.	Keynote Speaker	Affiliation	Time Allotment (WIB)	Moderator	Liaison Officer
1.	Dra. Nana Yuliana, MA., Ph.D.	The Indonesian LBBP Ambassador for the Republic of Cuba, concurrently with the Commonwealth of the Bahamas, Jamaica, the Dominican Republic and Haiti	09.00 – 10.00	Tiur Simanjuntak M.Pd.	Doeslohal Djumrianti, S.E.MIS., Ph.D
2.	Prof. Ramaraj Boopathy	Alcee Fortier Distinguished Service Professor of biological sciences at the Nicholls State University, USA	10.00 – 11.00	Prof. Hasan Basri	Dr. Nyayu Latifah Husni, M.T.
3..	Dr. Ing. Ahmad Taqwa, MT.	Director of Politeknik Negeri Sriwijaya, Indonesia	11.00 – 12.00	Jaksen M. Amin, M.Si.	Dr. Martha Aznury, S.Pd., M.Si.

PARALEL SESSION

No.	Theme	Room	Time	Moderator	Articles
1.	TRACK 1 (Engineering and Science)	1	13.00 – 16.00	Dr. Eng Tresna Dewi, M.Eng./ Ika Sulianti, ST, MT	15
2.	TRACK 1 (Engineering and Science)	2	13.00 – 16.00	Dr. Martha Aznury, M.Si./ Indah Purnamasari, M.Eng.	14
3.	TRACK 1 (Engineering and Science)	3	13.00 – 16.00	Fatahul Arifin, M.Eng, Ph.d./ Dr. Indrayani, S.T., M.T.	13
4.	TRACK 2 (Computer Science, Computer Engineering, Information System, Informatics Management)	4	13.00 – 16.00	Rika Sadariawati, M.Si./ M.Miftakhul Amin, S.Kom., M.Eng	13
5.	TRACK 2 (Computer Science, Computer Engineering, Information System, Informatics Management)	5	13.00 – 16.00	Dr. Nyayu Latifah H, MT./ Lindawati, S.T., M.TI	12
6.	TRACK 3 (Social Science)	6	13.00 – 16.00	Doeslohal Djumrianti, S.E.MIS., Ph.D/ Dr. Marieska Lupikawati	13
7.	TRACK 3 (Social Science)	7	13.00 – 16.00	Dr. Sari Lestari ZR/ Dr. Rita Martini	14
8.	SNAPTEKMAS 1	8	13.00 – 16.00	Yurni Oktarina, ST, MT/ Mouland Irwadi, SE. M.Si.	15
9.	SNAPTEKMAS 2	9	13.00 – 16.00	Leni Novianti, M.Kom./ Maivi Kusnandar, M.Kom	15
10	SNAPTEKMAS 3	10	13.00 – 16.00	M Husni Mubarok, M.Si./ Martinus Mujur, ST, MT	15
11	SNAPTEKMAS 4	10	13.00 – 16.00	Dr. Ade Silvia H, MT./ M. Sopian Soim, ST, MT	13

CLOSSING SESSION		
Event	Time	Room
– Closing Ceremony – Announcement of: 1. Best Paper FIRST IC 2021 2. Best Paper SNAPTEKMAS 2021 3. Best Presenter FIRST IC 2021 4. Best Presenter SNAPTEKMAS 2021 – Quiz Online	16.00– 17.00	Main Room

TRACK 3 (Social Science)

ROOM	:	6
TIME	:	Thursday, 21 October, 2021/ 13.00 - 16.30
ARTICLES	:	13
MODERATOR	:	Doeslohal Djumrianti, S.E.MIS., Ph.D/ Dr. Marieska Lupikawati

NO	Time	ID	AUTHORS	TITLE	AFFILIATION
1	13.00-13.10	3847	Ayu Chotibah, Bainil Yulina, Desi Apriyanty, Evada Dewata, Pridson Mandiangan	THE INNOVATION OF SOUTH SUMATERA TRADITIONAL BATIK E-COMMERCE APPLICATIONS	State Polytechnic of Sriwijaya
2	13.10-13.20	3683	M. Thoyib, Riza Wahyudi, Firmansyah, Darul Amri	THE ANALYSIS OF COST QUALITY ON PRODUCTIVITY OF IRON RAILING PRODUCTS IN SMALL AND MEDIUM BUSINESS IN PALEMBANG	State Polytechnic of Srwiwijaya
3	13.20-13.30	3757/3756	Nelly Masnila, Firmansyah, Jovan Febriantoko, Riana Mayasari, Jamaliah Said	Quality of Financial Reporting and Impact of GGG Implementation: Study on Local Government in Indonesia	State Polytechnic of Sriwijaya
4	13.30-13.40	3796	Evi Agustina Sari, Sri Gustiani, Yusri, Tiur Simanjuntak	An Error Analysis of English Sentence Construction in Writing Subject Made by the Students of the English Department at Sriwijaya State Polytechnics	State Polytechnic of Sriwijaya
5	13.40-13.50	3827	Edwin Frymaruwah, Farah Aida Ahmad Nadzri, Periansya, Evada Dewata	DISCLOSURE OF SUSTAINABLE PERFORMANCE IN HIGHER EDUCATION IN INDONESIA	State Polytechnic of Sriwijaya, UiTM
6	13.50-14.00	3976	Hendra Hadiwijaya Febrianty Rezania Agramanisti Azdy	Improvement of LPKA Class 1 Palembang Electronic Dashboard with Field Performance Monitoring	Palcomtech Polytechnic, STMIK PalComTech
7	14.00-14.10	3853/4034	Neneng Miskiyah, Purwati, Yulia Pebrianti, Keti Purnamasari, Nyimas Miftahul Jannah,	OPTIMIZATION OF INCOME PARAMETERS OF SONGKET CRAFTSMEN ON KOPERASI SONGKET PALEMBANG	State Polytechnic of Sriwijaya

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The Potential of Charcoal Gasification as an Eco-Friendly Fuel

Aria Yopianita[1,*] Aida Syarif[2], Muhammad Yerizam[2]

[1] *Master of Applied Renewable Energy Engineering, Sriwijaya State Polytechnic*
[2]*Chemical Engineering, Sriwijaya State Polytechnic*
[*]*Corresponding author. Email: ayopianita01@gmail.com*

ABSTRACT

The use of coal as primary energy in Indonesia will continue to be carried out, although slowly it will experience a significant decline until 2050 by the mandate of the National Energy Policy and the General National Energy Plan; this is more or less due to the potential of national coal reserves of 38.84 Billion Tons. However, planning for green coal or clean coal must be the first step by providing added value for coal through downstream coal gasification methods where the pilot project will be held at PT Bukit Asam as a state-owned enterprise. Coal gasification will produce by-products in the form of char which allegedly still has energy potential. As an effort to recycle when that pilot project is going operation, this char is then used as raw material to make briquettes. In this preliminary research, using coal samples with seam variation from PT Bukit Asam and the gasification process produces some char. After char characterization result by proximate and ultimate analysis, it is found that char experiences an increase in Gross Calorific Value grades from 5,804 cal/gr to 6,183 cal/gr (seam A1), from 5,794 cal/gr to 6,281 cal/gr (seam A2), from 5,837 cal/gr to 6,320 cal/gr (seam B1) and from 5,898 cal/gr to 6,407 cal/gr (seam C) and a significant decrease in sulfur levels from 1.18% to 0.38% (seam A1), from 0,41% to 0.30% (seam A2), from 1.12% to 0.59% (seam B1) and from 1.19% to 0.69% (seam C) and also a significant decrease of inherent moisture from 16.10% to 12% (seam A1), from 15.10% to 11.40% (seam A2), from 17.6% to 10.30% (seam B1) and from 14.8% to 9.9% (seam C). This result makes char potentially a raw material for solid fuels that are environmentally friendly.

Keywords: *"Coal", "Gasification", "Char", "Solid fuel"*

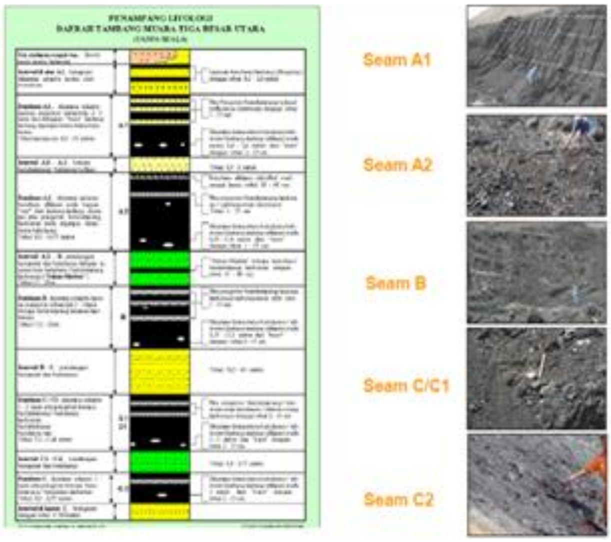
1. INTRODUCTION

Coal is one of the mining products included as one of the fossil fuels. Based on data British Petroleum (BP) Statistical Review of World Energy in 2021 (70th edition), the proven reserves of Indonesian coal for anthracite and bituminous types are estimated at 23,141 million tons and 11,728 million tons for the sub-bituminous and lignite types. Meanwhile, the world level coal reserves amount for anthracite and bituminous types and sub-bituminous and lignite types is about 753,639 million tons and 320,469 million tons, respectively [1]. In addition, according to data from the pers release on the website of Indonesian Ministry of Energy and Mineral Resources in 2021, total coal reserves in Indonesia are estimated at around 38.84 billion tons [2], where in addition to proven coal reserves, Indonesia has another data as coal resources predicted at approximately 143.7 billion tons.

Indonesia's coal resources quality is quite varied in terms of calorific parameters, ash and sulfur content, total moisture, and other parameters. About 60% of Indonesia's coal is in the medium rank of calorific coal or around 5100-6100 kcal/kg ADB (Air Dried Basis), another 30% coal quality is categorized as low rank with calorific value <5100 kcal/kg ADB), about 7% the coal quality is included in the high-rank category with calorific value 6100-7100 kcal/kg ADB and only 2% of the coal was included in the very high-rank category with calorific value more than 7100 kcal/kg ADB) [3]. This difference in quality in a coal formation is often characterized by differences in layers (stratigraphy) that reflect differences in the age of the coal.

One of the South Sumatra basins containing coal-bearing formations is the Muara Enim Formation [4] which there are several coal layers (coal strata or seam), with each coal seam having a thickness that is not always the same. In the Muara Tiga Besar area, part of

Muara Enim Formation, several coal seams have been explored and included in the measured reserves, namely seam A1, seam A2, seam B1, seam B, seam C1, and seam C2 like in figure 1 below.



Source: Geology and Exploration. PT Bukit Asam.

Figure 1. Lithology Section of Muara Tiga Besar Formation

Steam Power Plant *(PLTU)* is one example of direct use of coal that is widely used in Indonesia and around the world, where coal is burned in boilers to generate heat that will be used to convert water into steam which is then used to drive steam turbines and turn generators to produce electrical energy. By-products in the form of gas flue and ash from burning coal cause increased levels of air pollution. Coal releases gases (CO_2, N_2O, NOx, SOx, and Hg) that cause global warming and pollution that currently become the world concern. Besides that, coal mining also pollutes the environment with coal mine wastewater, but with electrocoagulation technology using aluminum electrode this can be overcome [5]. Therefore, the use of clean and efficient coal remains a challenge that needs to be pursued extensively in the framework of decarbonization while extending the life of its availability (coal conservation). In addition, to minimizing global environmental burdens, one way to increase the utilization of clean coal is by the coal gasification process. [6][7][8]. Besides the direct combustion by being the raw material of the power plant, low rank coal can also be used as an environmentally friendly fuel by making it as briquettes. The manufacture of coal briquettes aims to utilize low grade coal also to reduce the pollutant content of coal that are harmful to the environment [9].

Briquettes are the process of mixing one or more mashed materials (such as sawdust, bean shells, coconut coir, palm oil, rice husks, corn cobs, bamboo, and other flammable materials) into solid compression materials due to pressure and often using starchy materials such as starch cassava. [10].

Table 1. Coal Briquette Quality Standards

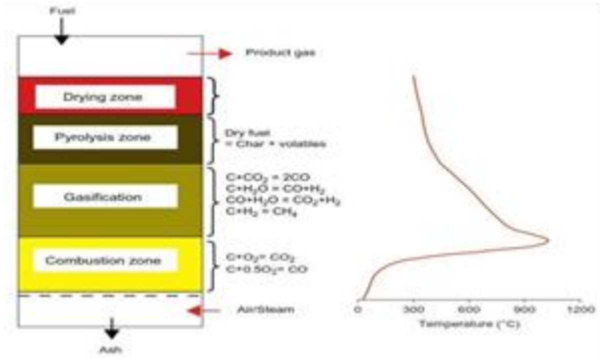
Briquettes	Moisture (%)	Volatile Matter (%)	Calorific Value (Cal/gr)	Total Sulfur (%)	Breaking Load (Kg/cm2)
Lignite carbonized	Max 20	Max 15	Min 4000	Max 1	Min 60
Non-lignite carbonized	Max 7.5	Max 15	Min 5500	Max 1	Min 60
Egg-type non-carbonized	Max 12	according to the coal	Min 4400	Max 1	Min 65
Wasp nest non-carbonized	Max 12	according to the coal	Min 4400	Max 1	Min 10
Bio-coal briquettes	Max 15	according to raw material	Min 4400	Max 1	Min 65

Source [11]

To increase the added value of coal by turning it into solid fuel through briquettes, focusing only on increasing the calorific value is not enough, apart from the nature of coal, which has a lot of solid carbon, at the same time coal also has low volatile matter. This condition results in a high ignition temperature [12][13]. Therefore, to anticipate this problem, coal briquettes will be added with biomass (agricultural/plantation waste). This is because the volatile matter content of the biomass is very high so that it allows ignition from low temperatures, which can then save the time and energy needed for ignition [12][14]. Efforts to make briquettes by mixing coal with biomass are called bio briquettes. Because it has a calorific value equal to the calorific value of coal and even exceeds it, coconut shell was chosen as an additive to increase the fuel value of bio briquettes [13]. Thus, in this study, the biomass that will be used as supporting material is a coconut shell, considering that this biomass has good thermal diffusion properties and can produce heat around 6500-7600 kcal/kg [13][15].

The converting process from solid fuels or some hydrocarbon-containing materials such as coal and biomass into combustion-capable gases like CO, CH4, and H2 with added a limited air supply (about 20% until 40% stoichiometric air supply) was known as the gasification process [16][17]. The difference between the gasification and pyrolysis process lies in the presence of air supply in the process. Biomass pyrolysis is commonly initiated from 300^{o}c temperature to 600^{o}c [17][18]. This process order and temperature are shown in figure 2 below. The product of pyrolysis generally depends on several factors, including pyrolysis temperature factor and also heating rate. In general, pyrolysis products can be classified [16]:

a. Solid products: rich in carbon content (char)
b. Liquid products: tar, hydrocarbons, and water
c. Gas products: (CO, H_2O, CO_2, C_2H_2, C_2H_4, C_2H_6, C_6H_6, etc.).



Source: [17]

Figure 2. Temperature Stages and Distributions in a Gasifier

The pilot project of coal gasification or down streaming coal to provide added value for coal in Indonesia will be held at PT Bukit Asam as a state-owned enterprise and has been confirmed in the law of the mineral and coal number 3 of 2020, mainly in article 102 paragraph 1 which is requiring for the mining industry to enhance the added value of minerals and coal which reads "IUP (mining license) or IUPK (special mining business license) holders at the production operation stage are required to increase the added value of minerals in mining business activities through: a) Processing and Purification of metal mineral mining commodities, b) Processing of non-metal mineral mining commodities, and c) processing of rock mining commodities" [19].

In the process of gasification, the desirable main product is syngas [12][20] that can be used in combined heat and power (CHP) engines. On the other hand, a by-product called char, is obtained. Disposal management of char as residues from an industrial for future gasification plants is very important [12] because the accumulation of char in a certain period of time as a stockpile can have an effect on the environment [21]. From the results of the literature study, it is found that the char gasification result may have increased the carbon value so that it can be an initial hypothesis that char still contains energy potential and a significant decrease in sulfur levels. With the initial premise, therefore, in this study, the results of waste in the form of char become a potential raw material for the manufacture of briquettes. The manufacture of briquettes from coal is one form of utilization of coal into environmentally friendly energy. The use of char from the gasification process is an effort to reprocess/recycle waste gasification that has been done before. The gasification industry in the future will be one of the downstream coal programs [22], so that the use of charcoal gasification in the future will be one of the projects for the industry.

Research similar to this study has been carried out. The study was taken from several references to research on making briquettes using coal as the primary material, which has a character resembling char from gasification combustion, and other studies that use variations in the composition of coal and biomass raw material.

So, in general, what distinguishes the proposed research from previous research as a research renewal is, this study tries to characterize bio briquettes using char as a by-product of coal gasification (recycle) with variations in layers or stratigraphy of coal raw materials for gasification, with the addition of coconut shell charcoal. As a mixture of biomass, analyze the effect of the ratio of the two on the quality of the briquettes and the emissions produced in its combustion to obtain an environmentally friendly solid fuel.

This preliminary research focuses on characterizing char as a by-product of the gasification process using several types of PT Bukit Asam's coal from different stratigraphies, which are expected to reflect differences in properties and quality. Contribution to the mining industry, in this case, PT Bukit Asam, is converting coal into gas fuel and utilizing char waste as recycled from the gasification plant process to the next project by making briquette with biomass added.

2. RESEARCH METHODOLOGY

2.1 Material

The coal used in this study is taken from the Muara Tiga Besar mine site of PT Bukit Asam with seam variation: seam A1, seam A2, seam B1 and seam C at the coordinates of 3º43'16,315"LS, 103º42'30,463", with mine brand MT 47 (4600 – 4800 kcal/kg, ar).

2.2 Coal Sampling

Coal sampling at the mining front using the sampling method named the channel sampling or front sampling. Sampling carried out on coal seams that have been exposed, such as on walls or floors in mines. Sampling of the coal using an in situ sampling model without a scale, or it can be said that the manual sampling method is human as an operator, the tools used are scoops and plastic bags.

Figure 3. Coal Sampling Activity

2.3 Research Method

In this research, there are two primary studies: the coal gasification process and the proximate and ultimate analysis in the laboratory of coal as a source of raw materials, char analysis of the by-products of coal gasification and as additional biomass coconut shells.

2.3.1 Coal Gasification

Procedures for obtaining char by coal gasification is the following steps:

1. The fuel used is coal obtained through outcrop sampling at the Muara Tiga Besar coal mining of PT Bukit Asam with seam variation. Before being used as a gasification raw material, this coal must be reduced in size to be incorporated into the reactor. Once the size is reduced, the coal is drained in the oven for 2 hours at room temperature. Coal that has been dried is put into an airtight plastic bag as much as 10 kg for one run.
2. Single Gas Outlet System Gasification Procedure. Put 10 kg of prepared coal into the reactor. Then burn with a flame igniter to start the combustion process. The air valve is left open, and make sure the valve on the syngas pipe is closed. The blower is turned on and fully opened the valve on the piping system. Wait ± 10 minutes until the coal becomes coal. Then the pyrolysis process will occur, and the char to be used will be formed in this process.
3. Char that has been obtained is then separated and characterized to find out its initial quality.

Figure 4. Char Side-Products of Coal Gasification.

2.3.2 Proximate and Ultimate Analysis

Before the gasification process is carried out, the coal is first carried out proximate and ultimate analysis to determine the content of the coal sample. After the gasification process is complete and char is obtained, it will then be carried out to laboratory for the following process, namely proximate and ultimate analysis. This characterization includes moisture, ash content, sulfur levels, volatile matter, fix carbon, and calorific levels.

1. Moisture
   a. Weigh empty containers in advance
   b. Put the sample in a container.
   c. Put in a preheated oven from 104°C to 110°C.
   d. Heat the container containing the weight of the sample for ± 1 hour.
   e. Open the oven, and quickly close the dry weighing bottle and cool in a desiccator.
   f. Immediately weighed it if it had reached room temperature.
   g. Calculates the value of water content with the formula [13]:

$$Water\ Content\ (\%) = \frac{m_2 - m_3}{m_2 - m_1} x 100\%$$

2. Ash Content
   a. Put the sample into the furnace, then heat it until the furnace reaches 700°C-750°C± 1 hour or until all samples burn perfectly to ashes.
   b. Lift the container from the furnace, place the lid on the cup and metal plate.
   c. Cool for 10 minutes, then put in a desiccator.
   d. Put the cold ash in the weighing cup and then calculate the ash level according to the formula. [13]:

$$Ash\ Content\ (\%) = \frac{m_3 - m_1}{m_2 - m_1} x 100\%$$

3. Sulfur Level
   Sulfur levels are carried out using the Eschka Method, as follows: [13]:
   a. Mixed 1 kg of the sample with 3 grams of Eschka.
   b. Heat the sample into the furnace slowly until the temperature reaches 800 ± 25°C for 1 hour. Heat at this temperature for ± 1.5 hours until the mixture melts perfectly.
   c. Cool the sample at room temperature, re-dissolve with 100 ml of hot water in a 200 ml chemical glass, heated into a hot plate for 1/2 - 3/4 hour, stirring occasionally.
   d. Filter it with filter paper and then wash with a material that does not dissolve with hot water. After several washes, transfer the material to filter paper and rewash it with hot water up to five times.
   e. Dilute the filtrate with 250 ml of methyl orange and neutralize with a solution of NaOH or Na_2CO_3, then add a solution of HCl 1 ml (1:9), boiled and add 10 ml or more of $BaCl_2$ solution with a slow pipette while stirring.
   f. Bring the solution back to be boiled for 15 minutes and let stand overnight. Then filtered with ash-free filter paper (Whatman filter paper

no.42) and wash with hot water until the filtrate does not form mud when added agno$_3$solution,

g. Put the sludge-filled filter paper into a porcelain cup which weight is already known, then burn it gradually in a furnace to a temperature of 800.
h. Cool it in a desiccator, then weigh by using formulas [13]:

$$Sulfur\,Total\,Content(\%) = \frac{(m_1 - m_3)x13{,}738}{m_1}$$

4. Volatile Matter
   a. Put the sample in a sealed container, then heat it to a temperature of 900°C for 7 minutes.
   b. Lift the container and leave it cool over a metal plate for 5 minutes, then put in a desiccator.
   c. Once cool, then weigh and calculate volatile matter with the formula [13]:

$$Volatile\,Matter\,(\%) = \frac{m_2 - m_3}{m_2 - m_1} x100\% - M_{ad}$$

5. Carbon Level

   Fixed carbon is calculated using calculations of other types of proximate analysis, namely by subtraction of ash levels, water content, and levels of volatile matter.

   Fixed Carbon = 100 %-(% M+%VM+%A)

6. Calorific Value

   Calorific Value level can be determined using a Bomb Calorimeter. The steps are as follows:
   a. Weigh 1 gram of sample into a cup.
   b. Put it in a calorimeter bomb.
   c. Put a 10 cm yarn burner on the wire connecting the two poles of the bomb head. Turn the yarn until the end touches the sample. The head of the bomb that already contains the sample is inserted into the Calorimeter bomb then rotates until it is closed and locked.
   d. Press "start" below, then "continue", enter the code name or sample ID, and then press enter, see the bomb ID, adjust the bomb head code, then press enter and type the weight of the sample and then automatically the tool will analyze the sample and calculate it.

3. RESULT AND DISCUSSION

This paper discusses the result of the characterization of coal samples from PT Bukit Asam with variation seam A1, seam A2, seam B1 and seam C. then the coal sample is gasified to obtain by-products in the form of char. This char sample is then tested for proximate and ultimate analysis again to determine the changes after the coal sample undergoes the gasification process. The chemical changes that occur are depicted in the table below:

Table 2. Proximate Seam Coal Analysis Values

No	Proximate Analysis	Coal Seam			
		A1	A2	B1	C
1	Total Moisture (%, ar)	27.5	31.9	30.7	31.70
2	Inheren Moisture (%, adb)	16.1	15.1	17.6	14.80
3	Ash Content (%, adb)	1.30	1.10	2.60	1.30
4	Volatile Matter (%, adb)	40.6	39.20	40.9	40.00
5	Fixed Carbon (%, adb)	42.0	44.60	38.90	43.90
6	Total Sulphur (%, adb)	1.18	0.41	1.12	1.19
7	Calorific Value (Cal/gr)	5,804	5,794	5,837	5,898

Table 3. Ultimate Seam Coal Analysis Values

No	Ultimate Analysis	Coal Seam			
		A1	A2	B1	C
1	Carbon (%, adb)	61.36	60.96	58.95	61.72
2	Hydrogen (%, adb)	6.38	6.21	6.37	6.30
3	Nitrogen (%, adb)	0.81	0.80	0.76	1.02
4	Sulfur (%, adb)	1.03	0.86	1.12	1.19
5	Oxygen (%, adb)	30.16	30.93	31.33	29.67

Table 4. Proximate Char Analysis Values Coal Gasification Results

No	Proximate Analysis	Char Gasification from Seam			
		A1	A2	B1	C
1	Inheren Moisture (%, adb)	12.0	11.4	10.3	9.9
2	Ash Content (%, adb)	0.70	1.70	3.70	7.60
3	Volatile Matter (%, adb)	40.0	41.5	42.7	41.7
4	Fixed Carbon (%, adb)	47.3	45.4	43.3	40.8
5	Total Sulphur (%, adb)	0.38	0.30	0.59	0.69
6	Calorific Value (Cal/gr)	6,183	6,281	6,320	6,407

Table 5. Ultimate Char Analysis Values Coal Gasification

No	Ultimate Analysis	Char Gasification from Seam			
		A1	A2	B1	C
1	Carbon (%, adb)	72.63	72.72	72.78	73.79
2	Hydrogen (%, adb)	4.48	4.53	4.46	3.26
3	Nitrogen (%, adb)	1.15	1.11	1.75	1.82
4	Sulfur (%, adb)	0.44	0.35	0.69	0.84
5	Oxygen (%, adb)	21.04	20.11	17.69	14.21

From tables 2 and 3, the results of the proximate and ultimate analysis of coal with several seams are obtained, namely seams A1, A2, B1 and C while tables 4 and 5 show the results of the proximate and ultimate analysis of the char gasification results from coal from seam A1, seam A2, seam B1 and seam C that have previously been analyzed. And from Figure.5 below, the graph that describes the proximate value of all the coal seams that are sampled, it can be seen that the difference in seams does not provide a significant difference in levels.

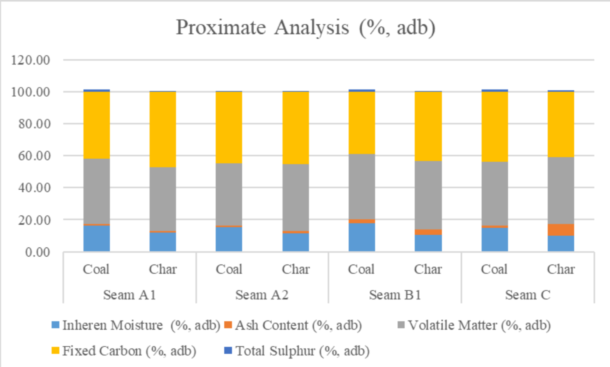


Figure 5. Proximate Analysis for All Seam

To make good and environmentally friendly briquettes, several critical indicators are needed: calorific value, sulfur content, water content and other indicators. The following is a graph that shows the difference in the chemical properties of the raw material of coal into char gasification results.

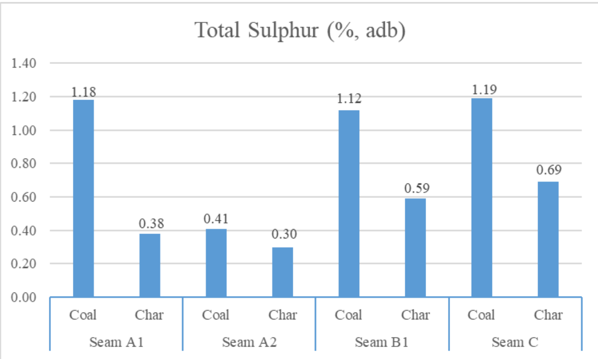


Figure 6. Analysis of Total Sulfur in Each Seam

Figure.6 above shows a significant decrease in sulfur content from each coal seam A1, seam A2, seam B1 and seam C, where the most significant reduction occurred in seam A1. This significant decrease in sulfur levels from 1.18% to 0.38% (seam A1), from 0,41% to 0.30% (seam A2), from 1.12% to 0.59% (seam B1) and from 1.19% to 0.69% (seam C). This shows that the gasification process reduces sulfur levels so that the char produced is safer for the environment.

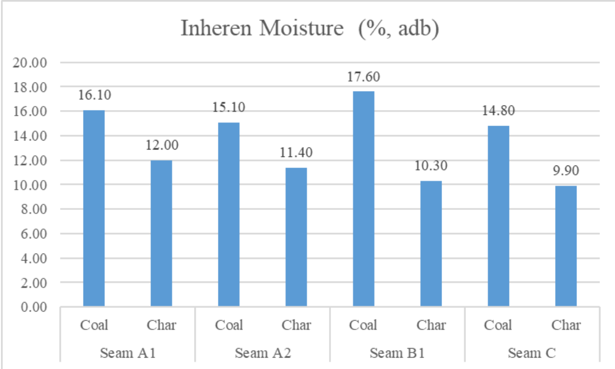


Figure 7. Analysis of Inheren Moisture in Each Seam

One indicator of a good briquette has low water content. The gasification process is generally proven to reduce water content significantly, making char an excellent raw material for briquettes. Significant decrease of inherent moisture in all seam are from 16.10% to 12% (seam A1), from 15.10% to 11.40% (seam A2), from 17.6% to 10.30% (seam B1) and from 14.8% to 9.9% (seam C).

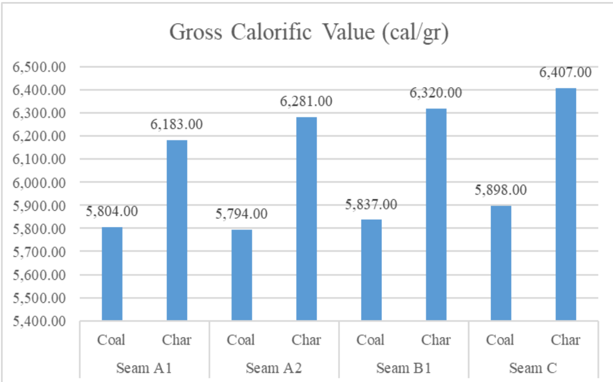


Figure 8. Analysis of Calorific Value in Each Seam

Table 6. Proximate Coconut Shell Analysis Value

No	Proximate Analysis	Coconut Shell
1	Moisture (% adb)	5.8
2	Volatile Matter (% adb)	18.2
3	Ash Content (% adb)	2.1
4	Total Sulfur (% adb)	0.04
5	Fixed Karbon (% adb)	73.9
6	Calorific Value (cal/gr)	7,274

Another indicator that is no less important is the calorific value, in Figure 8, it can be seen that there is an increase in the calorific value from the initial raw material of coal to char. An increase in gross calorific value grades from 5,804 cal/gr to 6,183 cal/gr (seam A1), from 5,794 cal/gr to 6,281 cal/gr (seam A2), from 5,837 cal/gr to 6,320 cal/gr (seam B1) and from 5,898 cal/gr to 6,407 cal/gr (seam C). This shows that the briquettes produced have the potential to have an excellent calorific value, especially when added with coconut shell biomass, as in the table.6 above where it can be seen that the calorific value of coconut shell charcoal is very high with low water content, so it is hoped that the addition of this coconut shell will increase the calorific value of the briquettes that will be produced.

4. CONCLUSION

From the results of the proximate and ultimate analysis of coal before gasification and char gasification results side result, obtained an increase in gross calorific value from each coal seam and a decrease in the total sulfur value and inherent moisture of each coal seam. After char characterization result by proximate and ultimate analysis, it is found that char experiences an increase in Gross Calorific Value grades from 5,804 cal/gr to 6,183 cal/gr (seam A1), from 5,794 cal/gr to 6,281 cal/gr (seam A2), from 5,837 cal/gr to 6,320 cal/gr (seam B1) and from 5,898 cal/gr to 6,407 cal/gr (seam C) and a significant decrease in sulfur levels from 1.18% to 0.38% (seam A1), from 0,41% to 0.30% (seam A2), from 1.12% to 0.59% (seam B1) and from 1.19% to 0.69% (seam C) and also a significant decrease of inherent moisture from 16.10% to 12% (seam A1), from 15.10% to 11.40% (seam A2), from 17.6% to 10.30% (seam B1) and from 14.8% to 9.9% (seam C).

Where the stratigraphic differences have no significant effect to characteristics of coal and char, this can be seen from the results of the proximate and ultimate analysis which are not much different so that the general use of char from any seam can be carried out on coal from the Muara Tiga Besar mines of PT Bukit Asam. And with the addition of coconut shell charcoal is expected to increase the calorific value of the briquettes that will be produced.

This shows that the char gasification by-product which is considered an undesirable material has energy potential that can be developed into raw material for briquettes as a more environmentally friendly fuel than direct coal combustion. The char characteristics meet the requirements according to the standard table of briquette quality, where the minimum heat value is 4000 KCal/ Kg, and the sulfur value is a maximum of 1%. With this research, it is expected to be one of the solutions for utilizing char as gasification industrial waste in the future, especially at PT Bukit Asam.

AUTHORS' CONTRIBUTIONS

All of the author are involved in the process of coal sampling, gasification process, proximate and ultimate analysis. The first and corresponding author contribution is responsible for coal sampling, data processing and manuscript writing. The second author is responsible for gasification process and char handling. The third author is responsible for proximate and ultimate analysis.

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