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Progress in Science and Technology Research Symposium

Letter of Acceptance

Padang, Indonesia, 17 Dec 2019

Dear authors: Wanda Afnison, Hasan Maksum, Nuzul Hidayat

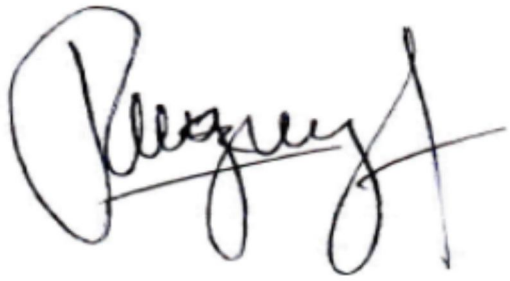
We are pleased to inform you that your abstract **GS.AB-7** entitled:

"THE EFFECT OF VIBRATION ENERGY HARVESTER MECHANISM TOWARD THE SHOCK ABSORBER EFFICIENCY"

has been **Accepted** at PSTRS conference to be held on 04 November 2019 in Padang, Indonesia.

Please submit your full paper and make the payment for registration fee before the deadline. For more information please visit our website.

Best Regards,



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List of Accepted Abstracts : Progress in Science and Technology Research Symposium (PSTRS) 2019

No	Abtracts ID	Title and Author(s)
1	GS.AB-1	**Mapping The Marine Tourist Zone Of Pasumpahan Island** Hendry Frananda, Fitri Mudia Sari
2	GS.AB-2	**Conceptual Framework Of Student Entrepreneurial Spirit On Blended Project-Based Learning Based On Production Approach** Muhammad Adri, Ganefri, Jalius Jama
3	GS.AB-3	**Expert System Of Analysis In Diagnosis For Gynecology** Devia Kartika, Agung Praman Putra , Mutiana Pratiwi, Rima Liana Gema, Silky Safira
4	GS.AB-4	**Anatomy And Secretory Cell Structure In Tropical Medicinal Plants** Rina Hidayati Pratiwi
5	GS.AB-5	**Diversity And Biopotential Of Neesia Altissima In Indonesia** Rina Hidayati Pratiwi
6	GS.AB-6	**Development Internet Of Things For Smart Factory In PT Wik East Batam** Muhammat Rasid Ridho, Muhammad Taufik Syastra
7	GS.AB-7	**The Effect Of Vibration Energy Harvester Mechanism Toward The Shock Absorber Efficiency** Wanda Afnison, Hasan Maksum, Nuzul Hidayat
8	GS.AB-8	**Effects Of Fuel Types On Performance In Gasoline Engine With Electronic Fuel Injection System** Ahmad Arif, Rifdarmon, Milana, Martias, Nuzul Hidayat
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10	GS.AB-10	**Study Of Experimental Capability Of Heat Release On Heat Exchanger For Straight Fin Radiator Fin Type Flat Tube With Cooling Liquid Variations** Nuzul Hidayat, M. Yasep Setiawan, Ahmad Arif, Wanda Afnison
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13	GS.AB-13	**Marketing Communication Strengthening Through Product Design And Packaging: Community Service On Solok Regency's Tenun Mulia** Okki Trinanda & Astri Yuza Sari
14	GS.AB-21	**Validation Of Learning Models Based On Concepts And Drill Methods In Biology Instructional Methodology Course** Relsas Yogica, Lufri, Arief Muttaqiin, Rahmadhani Fitri
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16	GS.AB-23	**Identification Of Potential Non-Gold Precious Metal Minerals In The Abai Area Based On Geochemical Approaches Based On X-Ray Fluorecences Analysis** Jana Hafiza, S.T., M.T., Fachrul Rozi Ramadhan, S.T.,M.T., Dr. Fadhilah, S.Pd., M.Si., Admizal Nazki, S.T.,M.Si.

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[GS.AB-7]

THE EFFECT OF VIBRATION ENERGY HARVESTER MECHANISM TOWARD THE SHOCK ABSORBER EFFICIENCY

Wanda Afnison, Hasan Maksum, Nuzul Hidayat

Universitas Negeri Padang

Abstract

The installation of vibration energy harvester mechanism[1][2] type Electromagnetic Regeneratif Shock Absorber (ERSA)[3][4] on vehicles can increase their energy efficiency. They will produce a new energy sources[5] which can be used to fulfill their energy needed. However, this mechanism installation can change the shock absorber efficiency value which affect the convenience of driving itself. This research used experimental method which the ERSA[6][7] mechanism installed on the usual shock absorber. ERSA is designed to be able to capture translation movement[8] from the shock absorber and change it to electrical energy like of linear generator mechanism. From the test, the efficiency increased 0.8-1.2% on each wheel. The increase of efficiency value thought is elektromagnetik damping force[9] which was produced by ERSA mechanism. From the result of the test, it can be concluded that ERSA installation is not very impactful towards efficiency value of shock absorber because the value is still below 10%[10].

Keyword : Vibration Energy Harvester, Electromagnetic Regeneratif Shock Absorber, Efficiency

Topic : Condensed matter: electrical, magnetic and optical

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The Effect of Vibration Energy Harvester Mechanism Toward the Shock Absorber Efficiency

The Effect of Vibration Energy Harvester Mechanism Toward the Shock Absorber Efficiency

W Afnison, H Maksum and N Hidayat

Automotive Department, Universitas Negeri Padang, Padang, Indonesia

Abstract. The installation of vibration energy harvester[1], [2] mechanism type Electromagnetic Regenerative Shock Absorber (ERSA)[3][4] on vehicles can increase their energy efficiency. They will produce a new energy sources which can be used to fulfil their energy needed. However, this mechanism installation can change the shock absorber efficiency value which affect the convenience of driving itself. This research used experimental method which the ERSA mechanism installed on the usual shock absorber. ERSA is designed *to* be able to capture translation movement from the shock absorber and change it to electrical energy like of linear generator mechanism. From the test, the efficiency increased 0.8-1.2% on each wheel. The increase of efficiency value thought is electromagnetic damping force which was produced by ERSA mechanism. From the result of the test, it can be concluded that ERSA installation is not very impactful towards efficiency value of shock absorber because the value is still below 10%.

1. Introduction

The evolution industry in Indonesia, especially in the automotive sector is currently increasing rapidly. This is based on data on the development of the number of motor vehicles taken from the Indonesian Central Statistics Agency. The types of vehicles recorded consisted of passenger cars, bus cars, freight cars, and motorbikes, which from 2014-2017 continued to experience an increase.

Table 1. Increasing of the number of motorized vehicles in Indonesia

Vehicle Type	Year			
	2014	2015	2016	2017
Passenger car	12.599.038	13.480.973	14.580.666	15.493.068
Bus	2.398.846	2.420.917	2.486.898	2.509.258
Commodity vehicle	6.235.136	6.611.028	7.063.433	7.523.550
Motorcycle	92.976.240	98.881.267	105.150.082	113.030.793
Total	114 209 260	121.394.185	129.281.079	138.556.669

Source : Korp Lalu Lintas Kepolisian Republik Indonesia (Korlantas Polri) 2017

Based on data above shows that with the increasing number of motor vehicles per year, not all of the energy generated can be utilized properly. Only 10-16% of fuel energy is actually used to drive a vehicle forward[5].

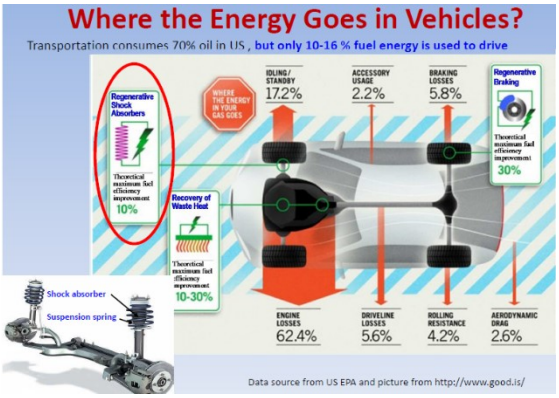


Figure 1. Energy losses in vehicle[6]

Some other parts of the car that can be harvested are suspension, crankshaft, brakes, and through solar panels on the roof of the vehicle. In this study, researchers used a suspension that was used in a vehicle. Motion up and down from the suspension when the vehicle passes a damaged or uneven road makes the vibration force on the suspension occur continuously. Under these circumstances it should be able to be utilized as energy that can be used or reapplied to vehicles.

Due to the availability of this energy, researchers are very interested in researching using VEH (Vibration Energy Harvesting)[6] technology. VEH technology (Vibration Energy Harvesting) is a system as an alternative harvester that is developed on vehicles where the working system of this tool is to utilize vehicle vibrations in the suspension system, the motion is the sliding motion of an object or space with the same distance in a certain direction. One of the tools made to utilize energy from suspension is Regenerative Shock Absorber (RSA)[1], [3], [4], which utilizes the relative motion between the suspension system and the vehicle body to produce electrical energy. In this study, it was concluded that Electromagnetic Regenerative Shock Absorber (ERSA) with alnico rod magnets is smaller in producing electrical energy compared to Neodymium ring magnets which is around 121-131 mV. This research is a development of previous research conducted by (ferry ddkk) where this time an analysis of the impact of installing the harvesting energy mechanism on ERSA on the shock absorber efficiency.

2. Related Theories

2.1 Vibration

Vibration does not usually occur only in the spring system or that is supported here the foundation of the system will also experience vibrations in the form of harmonic vibrations.

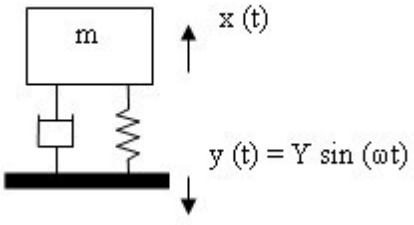


Figure 2. Excitation base

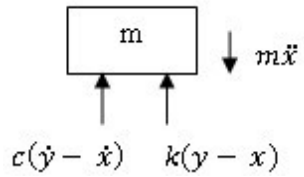


Figure 3. Free Body Diagram excitation base

From free body diagram in Fig. 3 and excitation on the base in Fig. 2 above, the equation of motion is obtained as below:

$$m\ddot{x} + c(\dot{x}-\dot{y}) + k(x-y) = 0$$

Steady state response of mass is, x_p (t) which can be expressed as an equation as below using the equation:

$$x_p(t) = \frac{kY\sin(\omega t-\theta_1)}{[(k-m\omega^2)^2+(c\omega)^2]^{1/2}} + \frac{\omega cY\sin(\omega t-\theta_1)}{[(k-m\omega^2)^2+(c\omega)^2]^{1/2}}$$

So the *system* equation above can be written:

$$x_p(t) = X\sin(\omega t-\theta_1-\alpha)$$

$$= \left[\frac{k^2+(c\omega)^2}{(k-m\omega^2)^2+(c\omega)^2}\right]^{1/2}\sin(\omega t-\theta_1-\alpha)$$

Where $\alpha = tan^{-1}\left[-\frac{C\omega}{k}\right]$ dan $\theta_1 = tan^{-1}\left(\frac{C\omega}{k-m\omega^2}\right)$

From this equation can be simplified to:

$$x_p(t) = X\sin(\omega t-\theta)$$

Where $\frac{X}{Y}$ is *displacement transmissibility*:

$$\frac{X}{Y} = \left[\frac{k^2+(c\omega)^2}{(k-m\omega^2)^2+(c\omega)^2}\right]^{1/2} = \left[\frac{1+(2\zeta r)^2}{(1-r^2)^2+(2\zeta r)^2}\right]^{1/2}$$

and,

$$\theta = tan^{-1}\left[\frac{mc\omega^3}{(k-m\omega^2)^2+(c\omega)^2}\right] = tan^{-1}\left[\frac{2\zeta r^3}{1+(4\zeta^2-1)r^2}\right]$$

The relationship between damping ratio, frequency ratio and displacement accountability is shown in the graph below:

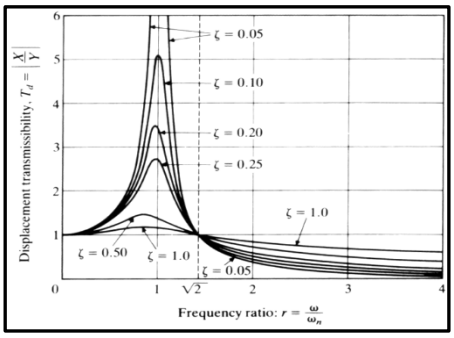


Figure 4. *Displacement transmissibility vs frequency ratio*

2.2 Logarithmic decrement

Logarithmic decrement is a display of reduced amplitude in damped free vibrations. By knowing how much logarithmic decrement (δ) in the system, the amount of damping constants in the system can also be known as well.

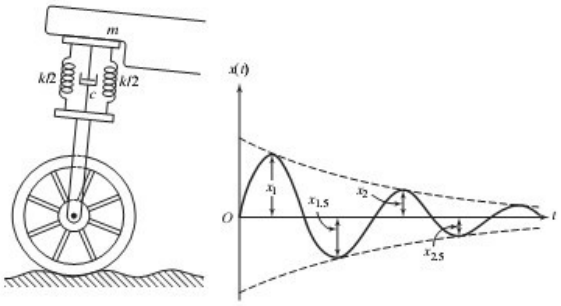


Figure 5. Single DOF on the shock absorber of a motorcycle with a silencer and analysis of the experimental system ada *shock absorber*[6]

From the picture above it is known with t as the time at the first and second peaks, showing the peak peaks referred to as x1 and x2, and forming a ratio:

$$\frac{x_1}{x_2} = e^{2\pi\zeta/\sqrt{1-\zeta^2}}$$

If the two segments in the naturalized logic are, then becomes:

$$\delta = \ln\frac{x_1}{x_2} = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$$

The above equation can also be written as: $\zeta = \frac{\delta}{\sqrt{(2\pi)^2+\delta^2}}$

From the displacement graph the time function will get the values of x1 and x2, then the value will be included in the decrement equation so that it becomes: $\zeta = \frac{\delta}{\sqrt{4(\pi)^2+\delta^2}}$

Where: ζ = *damping ratio*
δ = *logarithmic decrement* = $\ln\frac{x_1}{x_2}$

The value of the damping ratio itself can be found using the formula:$\zeta = \frac{C}{C_c} = \frac{C}{2\sqrt{km}}$

Where: k = spring stiffness (N/m)
C = damping value
m = mass (kg)

2.3 Damping Constant

From the value of the damping ratio can be found the amount of damping constants of the system with the following equation:

$$\zeta = \frac{c}{Cc}$$

Where:

$$Cc = 2\sqrt{km}$$

So the damping constant can be calculated with the following equation:

$$c = \zeta\, 2\sqrt{km}$$

Where:

ζ = *damping ratio*
k = spring stiffness (N/m)
c = damping constant (Ns/m)
C_c = *Critical damping*

Damping force is a force that dampens or reduces vibrations that occur in the system. The amount of the damping force depends on the value of the damping constant.

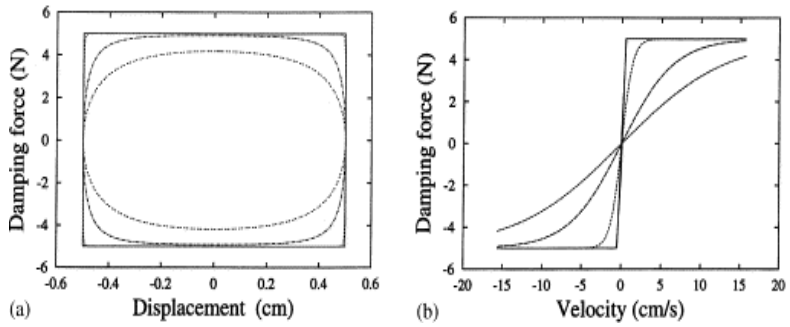


Figure 6. a. Graphic effect of damping force on displacement b. Graphic effect of damping force on speed

2.4 Effects of Vehicle Acceleration on Driver

The main movements experienced by the driver and passenger while driving are acceleration or deceleration and vibration. Information on the resistance of the human body to acceleration is very important as a reference in the design of the body's resistance to impact.

For the comfort criteria based on the acceleration according to ISO 2631 standard, shown in the graph in Figure 2.14 below.

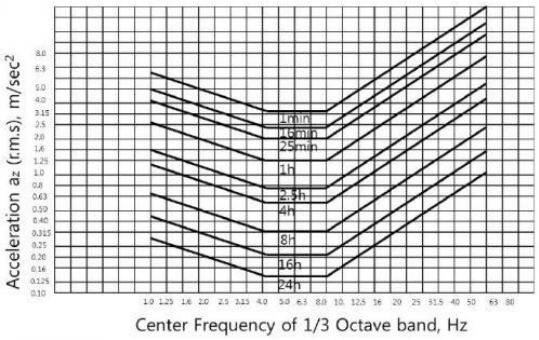
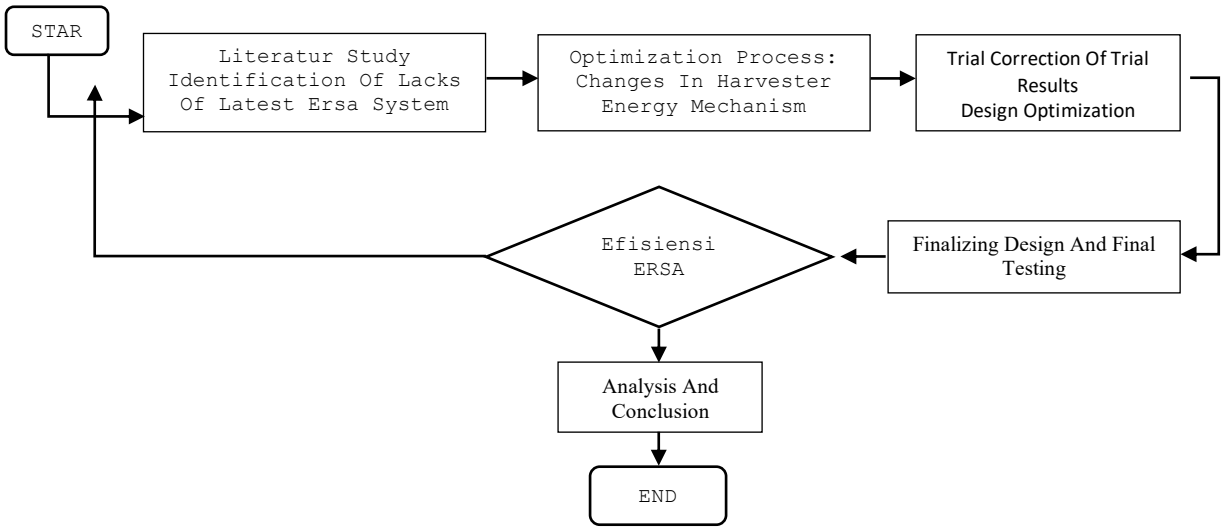


Figure 7. Graph of ISO 2631 standard driving comfort criteria

3. Research Methodology

This study aims to look at the effect of adding harvesting energy (VEH)[5], [7]–[10] mechanisms to the efficiency of the shock absorber. Shock absorber efficiency is how well the shock absorber is able to reduce vibrations caused by the road surface. The 100% efficiency value means that the shock absorber is able to reduce 100% of vehicle vibrations even though the condition of 100% efficiency is hardly found. This research used an experimental method and was carried out in the integrated laboratory of the Faculty of Engineering, Padang State University. Shock absorber that has been installed with vibration energy harvester mechanism is tested for its performance on the suspension test. The shock absorber efficiency value data obtained from the reading of the tool. The following schematic research diagram:



4. Result and Conclusion

In the process of testing the response of the vehicle obtained data from the suspension test as follows:

Table 2: Test results of vehicle responses

Designations	Information
Left wheel efficiency (%) E1	73
Right wheel efficiency (%) E1	75
Dissymmetry (%) E1	2
Left wheel weighing E1	123
Right wheel weighing E1	338
Axle weighing E1	461

For vehicle response graphs can be seen in the following image:

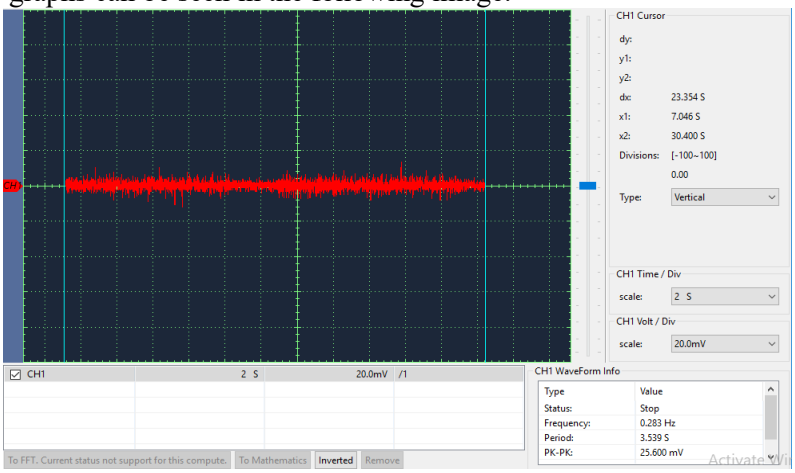


Figure 8. Graph of ERSA response

From the vehicle response testing data obtained the value of the shock absorber damping efficiency[11] for the left wheel 72% and right wheel 75%. There is a difference in the percentage of shock absorber efficiency around 3%. This condition is caused by the installation of a shock absorber which increases the value of the shock absorber so that it increases damping efficiency. From the test results it can be concluded that the differences that occur are still within the permissible tolerance limits (<10%)[12]

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PSTRS Progress in Science and Technology Research Symposium

THE 1ST PROGRESS IN SOCIAL SCIENCE AND TECHNOLOGY RESEARCH SYMPOSIUM (PSTRS)

Day 2, 08 November 2019

Venue: Room 1 - Room 4 are located in The Auditorium of Faculty of Economy UNP (Round Table)

Time	Activities	
PARALLEL 1 07.30 – 08.30	Room 1 PSTRS	Heri Prabowo, Fadhilah *Reduction of Heavy Metal Levels (Fe, Mn) in Mining Acid Water Using Constructed Wetland System in Coal Open Mine of PT Ba South Sumatera*
		Heri Prabowo, Yunasril *Analysis of Technical Aspects and Sustainable Environmental Mine Closure Plan PT. Bukit Asam Ombilin Sawahlunto West Sumatera Province*
		Jana Hafiza, S.T., M.T., Fachrul Rozi Ramadhan, S.T.,M.T., Dr. Fadhilah, S.Pd., M.Si., Admizal Nazki, S.T.,M.Si. *Identification of Potential Non-Gold Precious Metal Minerals in the Abai Area Based on Geochemical Approaches Based on X-Ray Fluorecences Analysis*
	Room 2 PSTRS	Irma Husnaini, Hastuti, Dwiprima Elvanny Myori, Asnil, Krismadinata *Design of PI, PID and Fuzzy Logic Controller for DC Shunt Motor*
		Khairi Budayawan; Vera Irma Delianti *The Design of Microstrip Antennas as The Sensor Using Three-Layered Substrate*
		Department Of Chemistry, FMIPA, Universitas Negeri Padang *The Characterization Of West Sumatera Iron Sand As A Raw Material To Synthesize Magnetic Nanoparticles*
	Room 3 PSTRS	Rahadian Zainul, Sri Wahyu Wardani, Arizka Tamarani, Devi Purnamasari *Design and Engineering of Tandem Hydrogen Generator-Photoreactor Systems For New Energy Investigation*
		Muhammat Rasid Ridho, Muhammad Taufik Syastra *Development Internet Of Things For Smart Factory In PT Wik East Batam*
		Sukardi, Reska Mayefis, Usmeldi *Development of Android Based Mobile Learning Media on Computer Assembly at Vocational High School*
	Room 4 PSTRS	Ahmad Arif, Rifdarmon, Milana, Martias, Nuzul Hidayat *Effects of Fuel Types on Performance in Gasoline Engine with Electronic Fuel Injection System*
		Erita Astrid, Ali Basrah Pulungan, Doni Tri Putra Yanto, Citra Dewi *Modified Particle Swarm Optimization (MPSO) to Solve Economic Load Dispatch with Multiple Fuel Sources*
		Irma Yulia Basri, Maswandi, Dedy Irfan, Dony Novaliendry *Lubrication of The Motorcycle Chain Automatically*
PARALLEL 2 08.30-09.30	Room 1 PSTRS	Riko Maiyudi, Yoszi Mingsi Anaperta, Fachrul Rozi Ramadhan, Tri Gamela Saldy *Methods of Enhancing Understanding of Natural Disaster Mitigation for high school students in the city of Solok*
		Edidas, Ilmiyati Rahmy Jasril, Ika Parma Dewi. *Peningkatan Keterampilan Mikroprosesor dan Mikrokontroler bagi*

		Guru-guru SMKN 2 Solok dan SMKN 2 GunungTalang
		Dedi Setiawan, Hendra Dani Saputra, Muslim, M. Nasir *Skill Training of Self-Based Motorcycle Workshop Business Building for Vocational School Students*
	Room 2 PSTRS	**Yaumal Arbi, Ahmad Fauzi Pohan, Ari Syaiful Rahman, Muvi Yandra, Gilang Ababil** *Acuifer Analysis with Seismic Methods in Parambahan Region*
		Rifky Pratama Putra, Harizona Aulia Rahman, M. Ilham Rasyidi, Rizaldi *Preliminary Geological Study and Mapping of Batu Kapal Cave in Solok Selatan, West Sumatera*
		Hendry Frananda, Fitri Mudia Sari *Mapping the Marine Tourist Zone of Pasumpahan Island*
	Room 3 PSTRS	**Heru Pramudia, S.St.Par, M.Sc** *A Specific LPG Gas Oven for Lemang Ketan Bamboo*
		Juli Sardi, Hamdani *Active Database Management System on Posyandu (Integrated Service Post) for Children Growth Monitoring*
		Devia Kartika, Agung Praman Putra , Mutiana Pratiwi, Rima Liana Gema, Silky Safira *Expert System of Analysis in Diagnosis for Gynecology*
	Room 4 PSTRS	**Heri Prabowo, Harizona Aulia, Riko Maiyudi** *Management Carbonate Industry In Mining Limestone Area Bukit Tui Padang Panjang City West Sumatera*
		Rahadian Zainul, Sri Wahyu Wardani, Arizka Tamarani, Devi Purnamasari *Design and Engineering of Tandem Hydrogen Generator-Photoreactor Systems For Newest Energy Investigation*
		Rina Hidayati Pratiwi *Anatomy and Secretory Cell Structure in Tropical Medicinal Plants*
09.30-09.45	**Coffee Break**	
PARALLEL 3 09.45-10.45	Room 1 PSTRS	**Hasanuddin, Hendri Nurdin, Waskito, Delima Yanti Sari** *Characteristic of Areca Fiber Briquettes as Alternative Energy*
		Aslimeri *Pembangkit Listrik Tenaga Surya*
		Heri Prabowo, ST.,MT , DR. Fadhilah, M.Si, Trigamela Saldy, ST.,M.T *The Feasibility Test of the Physical and Chemical Properties of Muaro Bingguang Pasaman Barat Iron Sand for Portland Cement*
		Nuzul Hidayat, M. Yasep Setiawan, Ahmad Arif, Wanda Afnison *Study of Experimental Capability of Heat Release on Heat Exchanger for Straight Fin Radiator Fin Type Flat Tube with Cooling Liquid Variations*
	Room 2 PSTRS	**Resti Fevria, Indra Hartanto** *Isolation of Lactic Acid Bacteria (Lactobacillus Sp) from Sauerkraut with Addition of Sugar*
		Rina Hidayati Pratiwi *Diversity and Biopotential of Neesia altissima in Indonesia*
		Hendri Nurdin, Waskito, Hasanuddin *Particle Board Made from Areca Fiber With Tapioca Adhesive*
	Room 3 PSTRS	**Indra Hartanto, Resti Fevria** *Training Making Milk Ginger for Singgalang Community Singgalang District Tanah Data*
		Tuti Lestari, Skunda Diliarosta, Firda Az Zahra *Need analysis for Biodiversity Teaching Material Development Based on Local Wisdom*

		Ta'ali And Fivia Eliza *Scada Based AC Motor Systems and Control Monitoring*
	Room 4 PSTRS	**Refdinal, Junil Adri, Budi Syahri** *Mesin Penyiang Gulma Sistem Roda Cakar*
		Junil Adri, Bulkia Rahim, Refdinal Dan Nelvi Erizon *Efektivitas Penggunaan Mesin Perontok Padi Sistem Lorong Hembus*
		Wanda Afnison, Hasan Maksum, Nuzul Hidayat *The Effect of Vibration Energy Harvester Mechanism Toward the Shock Absorber Efficiency*
		Muldi Yuhendri, Risfendra, Mukhlidi Muskhir, Hambali *Development of Automatic Solar Egg Incubator to Increase the Productivity of Super Native Chicken Breeds*