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PROCEEDING OF

CONFERENCE ON MANAGEMENT AND ENGINEERING IN INDUSTRY (CMEI) 2022

INDONESIA 4.0 ACCELERATION

TANGERANG, 21 - 22 SEPTEMBER 2022

MASTER OF MECHANICAL ENGINEERING
SWISS GERMAN UNIVERSITY

Preface from the Chairman of the Conference on Management and Engineering in Industry (CMEI)

Dena Hendriana, B.Sc., S.M., Sc.D.

Head Department of Master of Mechanical Engineering, Faculty of Engineering and Information Technology, Swiss German University

Welcome to the fourth Conference on Management and Engineering in Industry (CMEI). This is conference is conducted by Master of Mechanical Engineering in the Swiss German University at Alam Sutera, Tangerang, Indonesia. The conference is open for all academic community to share the knowledge in the areas of management and engineering which are applicable in the industry. It is held on Wednesday, 21 September 2022 in the campus of Swiss German University at Prominence Tower, Alam Sutera. The theme of this conference is “Indonesia 4.0 Acceleration”. This theme is aligned with Master of Mechanical Engineering vision and mission to prepare our students for the era of Industry 4.0 in the global economic.

There are eight papers presented in this event with the topics related to the theme. We thank reviewers who have been working hard to improve the quality of the papers until this conference proceeding ready to be published on time. We thank all the members of the committee who prepare and run the event. We thank Rector, Vice Rectors, and Dean of Faculty of Engineering and Information Technology for their support on this event.

We thank God that we have run the event of the conference smoothly and published the conference proceeding on time. We hope that this event is beneficial for everybody and also the proceeding to be beneficial for the readers.

Best Wishes,

Dena Hendriana, B.Sc., S.M., Sc.D.

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CMEI
Conference on Management and Engineering in Industry

CMEI 2022 PROGRAM

21- 22 September 2022

Date: 21 September 2022

Time	Location	Activities
08.00 – 08.30	Google Form	Registration
08.30 – 08.35	Main Room	National Anthem: Indonesia Raya
08.35 – 08.40		Opening by MC
08.40 – 08.43		Praying
08.43 – 08.47		Report by Chairperson
08.47 – 08.51		Report by Conference Chair
08.51 – 08.55		Welcoming Address by The Rector
Keynote Session		
08.55 – 09.27	Main Room	Keynote Speaker 1 **Johnny G Plate, S.E.** Minister of Communication and Informatics Republic of Indonesia
09.27 – 09.59		Keynote Speaker 2 **Dr. R. Hendrian, M.Sc.** Deputy for Utilization of Research and Innovation, BRIN
09.59 – 10.13		Break
10.13 – 10.33		Plenary Speaker 1 **Dr. Nuki Agya Utama** Executive Director of the ASEAN Centre for Energy (ACE)
10.33 – 10.53		Plenary Speaker 2 **Dr. Waseem Haider** School of Engineering and Technology, Central Michigan University, USA
10.53 – 11.23		Q & A Plenary Session
11.23 – 11.43		Seminar by Sponsor
11.43 – 13.00		Break
13.00 – 15.40	**Parallel Session**	
15.40 – 15.45	**Announcement of the Best Paper (Head of Master Mechanical Engineering**	
15.45 – 15.55	**Closing of the Seminar (Head of Master Mechanical Engineering)**	

CMEI 2022 Parallel Session

Date: 21 September 2022
Room: Breakout Room (Zoom)

Moderator: Dr. Henry Nasution

Time	Presenter	Title
13.00 – 13.20	**Firdaus Agung Syafutra**, Gembong Baskoro, Aditya Tirta Pratama	Relationship Between Productivity and Employee Involvement at PT. UTX Site TGR
13.20 – 13.40	**Rustanto**, Gembong Baskoro, Aditya Tirta Pratama	Improving Maintenance Strategy Scania R580 by Using FMEA in Full Maintenance Contract PT. SIS Adaro
13.40 – 14.00	**Willian Septianuggraha M.**, Tanika D Sofianti, Gembong Baskoro	DFMEA, PFMEA for Improving Maintenance Program of Hydraulic Spare Parts: A Case Study in Indonesia Heavy Equipment Distributor Company
14.00 – 14.20	**Himawan Kunto D.A.**, Henry Nasution, Dena Hendriana	Design and Development Vehicle Anti-Collision Warning System
14.20 – 14.40	**Nelson Purba**, Henry Nasution, Widi Setiawan	Application of Computer Vision for Counting Oil Particle Contaminants
14.40 – 15.00	**Syaifuddin Zuhri**, Dena Hendriana, Henry Nasution	Lapping Machine with Arduino for Overhaul Hydraulic Pump at Small Hydraulic Excavator Komatsu
15.00 – 15.20	**Hery Cahyadi**, Henry Nasution, Cuk Supriyadi Ali Nandar	Drowsiness Detection with Computer Vision for Heavy Equipment Hauler
15.20 – 15.40	**Yudhistira Nizar**, Dena Hendriana, Hanny J. Berchmans	Automatic Warning System to Prevent Collisions and Provide a Safe Distance Between Heavy Duty-Trucks

Content

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Lapping Machine with Arduino for Overhaul Hydraulic Pump at Small Hydraulic Excavator Komatsu

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Abstract*—Hydraulic excavators are generally used in the construction, forestry, agricultural, and mining sectors for activities such as land clearing, cut and fill in road, bridge, and dam construction, spreading material in road construction, maintenance, pipe installation, canalling, loading onto trucks, and as a rock breaker or building. The treatment that is considered good is the treatment that produces the minimum possible downtime but, of course, with the lowest possible maintenance cost. About 70% of damage to hydraulic equipment is caused by problems in maintenance and the selection of hydraulic oil. During the hydraulic pump overhaul work, there are several work processes, including the lapping of the cylinder block with the valve plate, which takes about 16 hours because the lapping process is done manually by a mechanic. The lapping machine with Arduino that is installed and operated properly in the hydraulic pump overhaul process can reduce lead time in the lapping process and be faster and more precise than the manual method. The resultant lapping machine can reduce the lead time from 16 hours to about 15 minutes, and it can also save about 130 million IDR per year, which is 93% more efficient than manual lapping.

***Keywords*— lapping machine, excavator, overhaul, hydraulic pump, piston pump, arduino**

I. INTRODUCTION

Hydraulic excavators are generally used in the construction, forestry, agricultural, and mining sectors for activities such as land clearing, cutting and filling in road, bridge, and dam construction, spreading material in road construction, maintenance, pipe installation, canaling, loading onto trucks, and as a rock breaker or building. Heavy equipment must be treated like a production tool, that is, so that it is always in prime condition and can work continuously with minimal downtime. This can be achieved with good care and maintenance. The treatment that is considered good is the treatment that produces the minimum possible downtime but, of course, with the lowest possible maintenance cost. Thus, errors in carrying out treatment maintenance on heavy equipment account for a large portion of around 72% [1].

Hydraulic oil is an important element because it acts as a medium to transmit pressure. It plays an important role as a coolant and lubricant for sliding parts. About 70% of damage to hydraulic equipment is caused by problems in maintenance and the selection of hydraulic oil. As the hydraulic oil is used, it becomes contaminated by the entry of dirt and water, so the condition of the oil is generally checked by the following four items: discoloration, water content, viscosity, and acidity (alkalinity). Of these, the items that most frequently lead to damage to the equipment are water and contaminants causing discoloration [2–3].

Due to contamination of hydraulic oil from the outside, this causes increased wear of the cylinder block components (Fig. 1) on the hydraulic pump, which results in internal leakage of hydraulic oil. This causes the hydraulic oil pressure to drop, so that the performance of the unit decreases.

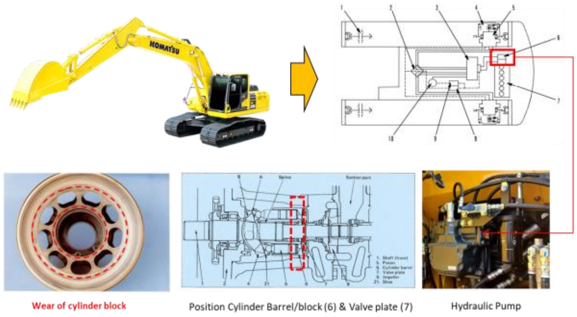

Fig. 1. PC200-8 wear of cylinder block component [1-3]

In the hydraulic pump overhaul process, there are several stages of the work process, namely pre-washing, disassembly, measurement, lapping, installation, test bench, painting, and delivery. However, the lapping process carried out by mechanics takes more than 16 hours because the lapping process is done manually. This is because there are no special tools, which causes the hydraulic pump overhaul work time to be long.

The following are the steps for the manual lapping process by a mechanic, as shown in Fig. 2 [4-10]:

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1. Visually check the wear on cylinder block components
2. Determine the depth level of wear of components
3. Prepare a grinding paste and apply it to the surface of the cylinder block component
4. Put the plate and cylinder block down
5. Turn the block cylinder manually until the flatness of the cylinder block & plate surface is equal (no gap)
6. Final check of the cylinder block

Fig. 2. Manual Lapping by Mechanic

II. METHODES

A. Conceptual Design

As previously explained, the process of applying a lapping machine to cylinder block components still uses the manual method by the mechanic. The implementation of this manual lapping machine takes about 16 hours. This greatly affects the productivity of mechanical performance. Based on these things, a tool was developed that can help reduce the length of the lapping machine work and still produce quality lapping results [11-15]. The basic concept of the tool to be developed can be seen in the following Fig. 3.

Fig. 3. Input, process, and output diagram

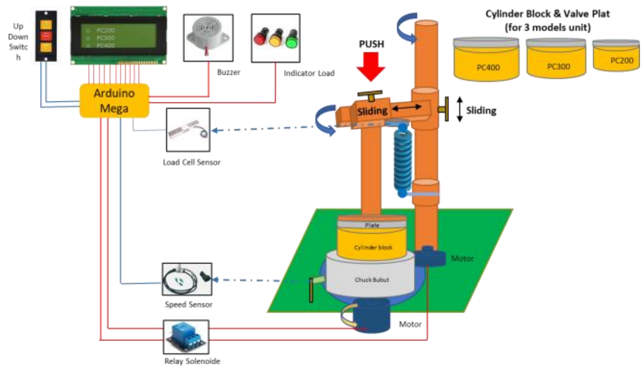

Fig. 4. Design tools lapping machine with arduino

Fig. 4 shows the rotational speed of the lathe chuck. The compressive force of the spring cylinder block will be read by the sensor, and the switch button then becomes the input for further processing by the microcontroller. This microcontroller then processes and decides based on the information provided by the three sensors. Output from the microcontroller by giving a digital signal to the LCD Panel to be able to provide actual information on the reading of the rotational speed of the lathe chuck, the pressure force of the spring and display the length of time the main motor rotates according to the input of the menu options on the screen. The alarm buzzer serves to provide information with an alarm sound that another 60 seconds will be completed the lapping machine process with the signal that the main motor has stopped. While the Led Indicator serves to inform the spring compressive force according to the standard compressive force of 6 kg/m², where the yellow led color indicates a spring compressive force of less than 6 kg/m², the green led color indicates a spring force value equal to 6 kg/m² and the red warning led indicates a spring force value of more than 6 kg/m². This tool works based on the visual results of manually checking the wear of the cylinder block and the level of density/matching between the cylinder block and the plate. where there are 3 conditions based on the percentage of wear as in Table 1 below.

TABLE I
SIMULATION CONDITION

Condition	Range Flatness (%)	Grinding Paste Type	Force Plate (Kg)	Speed Motor (rpm)	Time (Menit)
1	1-15	Very Fine	6	50-80	20
2	16-30	Fine	6	50-80	20
3	31-50	Coarse	6	50-80	20

After getting the percentage value of wear, lapping is carried out between the cylinder block and the plate, that is rotated by a DC motor which is controlled using an Arduino mega 2560 The cantering position of the cylinder block is carried out using a chuck lathe and the value of the compressive force between the plate and cylinder block is 6 kg/m. The last step is to determine the type of grinding paste used based on the level of grinding value (Very Fine, Fine, and Coarse). Fig. 5 and Fig. 6 show the concept of how the tool lapping machine with Arduino works in general, as well as a device block diagram with a list of materials and components used in the device.

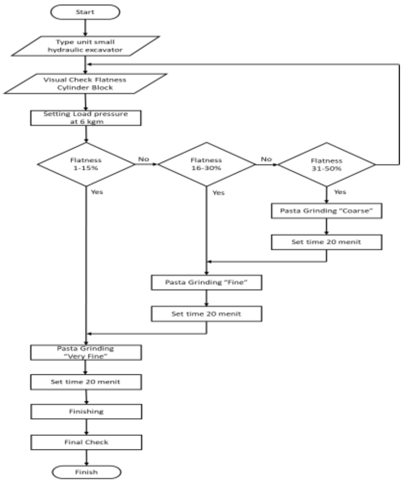

Fig. 5. Tools lapping machine flow diagram.

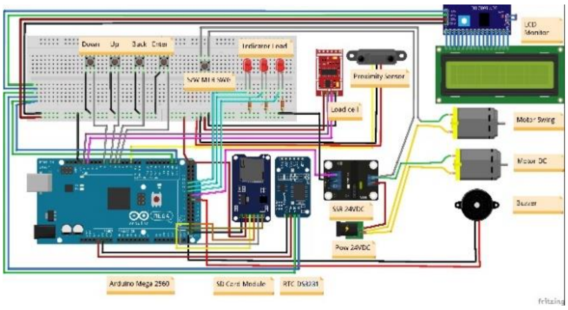

Fig. 6. Device block diagram.

B. *Sensor Working Test*

Before assembling all components, including sensors, according to the block diagram above, a working test is carried out first, is shown in Fig. 6. The test is carried out by gradually placing a load on the load cell sensor, which is compared with the actual load using an industrial digital scale. The reading from the load sensor displayed on the 20x4 LCD screen with I2C monitor is then compared with the actual load with the value reading load cell sensor to determine the accuracy of the reading from the load cell sensor.

Fig. 6. Load cell sensor working test

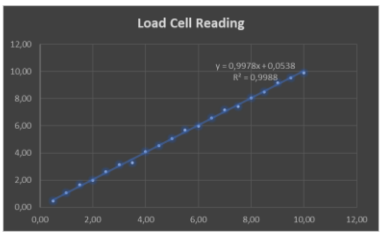

Fig. 7. Load cell sensor reading

Fig. 7 explains that the relationship between the value generated by the load cell sensor and the actual value of the load on the digital scale is linear. From the graph above, it is shown by the residual value (R2), whose value is 0.9988 or close to 1. This further strengthens the fact that the load value generated by the load cell sensor with the digital scale load value is the actual load and is linear with an accuracy of 99%. Testing the function of the load cell sensor is done by placing the sensor on the Lapping Machine tool stand, which is pulled with a spring as the basis for the amount of pressure during the lapping process. There are three indicator lights as an indicator of the value of the load or force from the spring. If the load cell value is below 5.5 Kg then the indicator light is yellow; if the load cell value is between 5.6 - 6.5 Kg, then the light indicator is green; and if the load cell value is more than 6.6 Kg, then the indicator light is red (overload or overpressure). Below is the result of the load cell sensor test in shown as Table 2.

TABLE II
RESULT OF LOAD CELL SENSOR TEST

Condition	LED Indicator	Status
Load below <= 5,5 Kg	Led Yellow	Underload
Load 5,6 – 6,5 kg	Led Green	Standart
Load above >=6,6 Kg	Led Red	Overload

After measuring the speed of the DC motor using an industrial tachometer, a speed sensor circuit is used, which consists of a proximity infrared sensor E18-D80NK as a speed sensor, an Arduino Mega 2560 as a controller, and a 20x4 LCD with I2C to display the speed of the DC Motor, then compared with the speed reading of the Tachometer. industry with the reading value of the infrared proximity sensor E18-D80NK, to determine the accuracy of readings from the infrared proximity sensor E18-D80NK. Below the Motor speed sensor reading is shown in Fig. 8 with an accuracy of 77.8%.

Fig. 8. Fan speed sensor working test.

III. Result and Discussion

As previously described, most of the components contained in the block or circuit diagram are placed in one box, which is then placed on the lapping machine table, a location that can be accessed by mechanics who operate the lapping machine tools. Except for the two sensors, namely the load cell sensor, and the DC motor speed sensor, as well as the solid-state relay (SSR) and the variable speed dimmer for the DC motor and power supply, which are placed under the table, which is shown in Fig. 9.

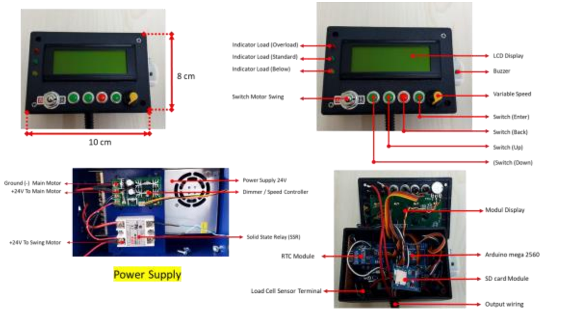

Fig. 9. Front, back, and inside box view.

The box is then placed on a lapping table and gauge for easy access or viewing by the mechanic operating the lapping machine tool. The following are the results of the lapping tools that have been installed together with several components and monitor panels, as shown in Fig. 10.

Fig. 10. Lapping machine tools with arduino

When entering the main menu of the lapping machine, there is a unit selection menu (PC200-8, PC3008 & PC400-8). Click enter according to the unit choice. then enter the wear percentage (flatness) menu (1-15%, 16-30%, and 31-50%) then enter the grinding paste selection menu (Very fine, fine, and coarse) and then enter the time setting menu according to standard operation as shown in Fig. 11.

Fig. 11. Menu monitor panel.

The device that has been designed, validated, or tested for the function of the sensors and installed on the table then carried out several simulations of conditions to ensure whether the tool can work according to the program that has been made previously.

1. First State Simulation Result

Fig. 12 shows the simulation results for condition 1.

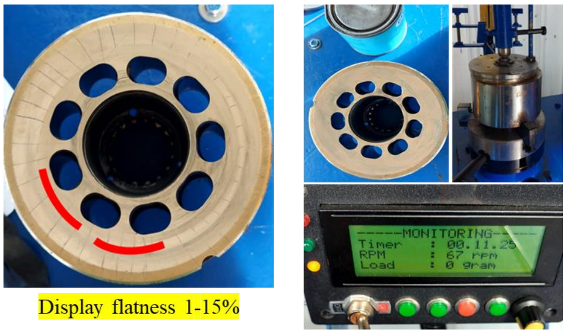

Fig. 12. First state simulation display result.

The determination of the flatness percentage is based on the number of pencil lines that are cut when the plate is rotated around the cylinder block. From the results of the first simulation test, the results obtained an evenness level of 1-15%, so for determining the type of pasta used, it was Very fine pasta with 20 minutes. Below, the display process lapping flatness 1-15% is shown in Table 3.

TABLE III
FIRST STATE SIMULATION RESULT

Condition	Range Flatness (%)	Type Pasta Grinding	Force Plate (Kg)	Speed Motor (rpm)	Actual Time (Menit)
1	1-15%	Very Fine	6	30-50	10

Based on the results of simulation test 1 (flatness 1-15%) the lapping process time is about 10 minutes with a motor speed of 30-50 rpm.

2. Second State Simulation Result

Fig. 13 shows the simulation results for condition 2. The determination of the flatness percentage is based on the number of pencil lines that are cut when the plate is rotated around the cylinder block. From the results (Table 4) of the first simulation test, the results obtained an evenness level of 16-30%, so for determining the type of pasta used, fine pasta with 20 minutes.

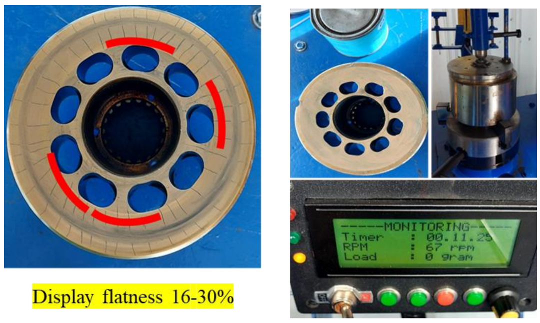

Fig. 13. Second state simulation display result.

TABLE 4
FIRST STATE SIMULATION RESULT

Condition	Range Flatness (%)	Grinding Pasta Type	Force Plate (Kg)	Speed Motor (rpm)	Actual Time (Menit)
2	16-30%	Coarse	6	50-80	10

Based on the results of simulation test 2 (flatness 16-15%) the lapping process time is about 10 minutes.

3. Third State Simulation Result

The determination of the flatness percentage is based on the number of pencil lines that are cut when the plate is rotated around the cylinder block, as shown in Fig. 14. From the results (Table 5) of the 3rd simulation test, the results obtained an evenness level of 31-50%, so for determining the type of pasta used, coarse pasta with 20 minutes. Applying coarse grinding paste to the cylinder block layer and then placing the cylinder block on top of the lathe chuck for centering. Determine the value of the spring pressure of 6 kg, and activate the power supply lapping machine, and select the display menu according to the desired unit.

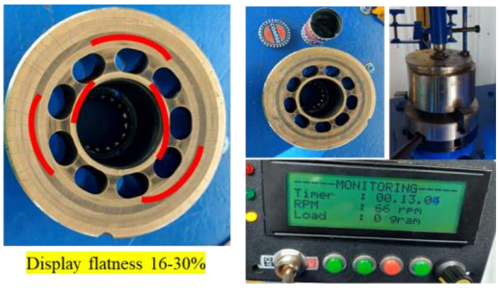

Fig. 14. Third state simulation display result.

TABLE 5
FIRST STATE SIMULATION RESULT

Condition	Range Flatness (%)	Grinding Pasta Type	Force Plate (Kg)	Speed Motor (rpm)	Actual Time (Menit)
3	31-50%	Coarse	6	50-80	15

Based on the results of simulation test 3 (flatness 31-50%) the lapping process time is about 15 minutes.

With lapping machine tools, we can save about 130 million IDR/years or 93% more efficiently than manual lapping. The data is shown in Table 6.

TABLE 6
SAVING COST JOB LAPPING

No	Activity Lapping	Time (Hours)	Man Hours Mechanic (Thousand IDR)	Cost Make Tools Lapping (Thousand IDR)	Work Order / Years	Total Cost (Thousand IDR)
1	Lapping Manual (before)	16	350	-	25	140000
2	Lapping Machine (after)	0,25	350	7441 (First Invest)	25	9629
	Saving Cost (IDR)					**130372**
	Saving Cost (%)					**93%**

IV. CONCLUSION

This lapping machine tool was successfully used with high-quality lapping and precision. It can also reduce the lead time from 16 hours to about 15 minutes.

The results show that coarse grinding paste is used for lapping very worn cylinder blocks so that it will speed up the lapping process, but after completion, the finishing process must be carried out with a very fine grinding paste type to get better and more precise lapping results.

With lapping machine tools, we can save about 130 million IDR/years or 93% more efficiently than manual lapping.

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