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Optimizing Mold Maintenance with a New Mold Flipper Design

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ABSTRACT

Molding is a critical production process involving the use of rigid frames or models, known as molds, to shape raw materials. Injection molding specifically deals with thermoplastics like Polystyrene and Acrylonitrile Butadiene Styrene (ABS). This research focuses on designing and constructing a flipper molding tool to enhance mold maintenance efficiency. Employing a descriptive research method, data was collected through direct observation, company references, and related literature. The analysis revealed that Carbon Steel (S45C) is used in the tool's construction. The design process includes stages such as design making, material selection, cutting, milling, grinding, drilling, welding, and assembly. The new Flipper Clamping tool is expected to significantly ease mold maintenance by reducing the need for two operators to a single operator using a lever mechanism to handle molds weighing over 200 kg

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Keywords: Injection Molding, Mold Flipper, Maintenance

1. Introduction

Molding is a crucial manufacturing process involving the shaping of raw materials using rigid frames or models known as molds. This process encompasses several techniques, each tailored for specific applications and materials. Injection molding, for example, forms objects by injecting molten plastic into a mold, where it cools and solidifies into the desired shape [1]. This technique is widely used due to its efficiency in producing high-precision parts with consistent quality. Injection molding involves several key steps: thermoplastic material is heated to a temperature range of 175°C to 290°C, which affects its viscosity and flow into the mold [2]. The material is then injected into the mold cavity under pressure, cooled, and ejected [3]. This process allows for physical changes in the material, making it suitable for recycling [4].

Molds themselves can be quite heavy, often ranging from 300 to 400 kg depending on their size and the specific requirements of the product [5]. This weight can pose challenges for maintenance, often requiring significant manual effort. The softer the formulation, which means high plastic content, requires a low temperature, while the harder formulation requires a high temperature. Difficult, large particle shapes and a large number of cavities and long runners cause high or rising temperature demands [6]. To address these challenges, the authors propose a research study titled "Optimizing Mold Maintenance with a New Mold Flipper Design." This study aims to develop a tool that simplifies and enhances the efficiency of mold maintenance

1.2 Definition of Molding

Molding is a manufacturing technique that uses molding tools to produce three-dimensional products with a specific shape. The molding tools used are usually shaped like rigid frames or empty frames that can be filled with liquid [7]. Molds in PT XYZ weigh around 200-300 kg depending on the type; therefore it has a special way of maintaining or repairing molds.

Figure 1. Mold AMB Charging

Molding techniques are divided into several types according to the process, namely:

a) Injection Molding

Injection molding is a manufacturing technique where metal, plastic, or other materials are melted and then injected into a mold. Once the mold is completely filled, the molten material is then cooled and solidified to obtain the desired final shape [8].

b) Compression molding

Compression molding is a manufacturing technique that utilizes a combination of pressure (compression) and heat to form products with specific shapes and sizes [9]. In the process, the liquid material that has been inserted into the mold cavity is then pressed and heated, resulting in the desired product shape.

c) Blow Molding

Blow molding is a manufacturing technique for making hollow products, such as plastic bottles, beverage cups, and so on. This technique begins with making a parison (liquid blob in the form of a pipe cross section) and inserting it into a blow molding machine [10]. After that, air is blown in through the holes of the pipe section. Due to air pressure, the liquid blob will adjust to the shape of the mold and be left until it becomes solid.

d) Extrusion Molding

Extrusion molding is a manufacturing technique usually used for plastic products. This technique is actually similar to injection molding, but the difference is that the product manufacturing process uses a cross-section profile with a continuous length [11]. Typically, extrusion molding is used to manufacture continuous length products, such as sheets, pipes, hoses, wire covers, filaments and fibers, and building structure components.

e) Transfer Molding

Transfer molding is a manufacturing technique that involves inserting materials into a closed mold. This technique is like injection molding, but transfer molding uses higher pressure to fill the mold cavity evenly.

2. Methodology of Research

This research employs descriptive methods to understand and develop a flipper mold tool. Data was collected through direct observation, reference books, company records, websites, and academic journals. Descriptive analysis was utilized to interpret the data, and the research was conducted over four months, from December 2023 to March 2024, at Jl. Surya Utama Kav I3-I4, Kutamekar, Kec. Ciampel, Karawang, West Java 41363.

2.1. Tools and Material

The following are the tools and materials used in this research.

a. Laptop
b. Autodesk Inventor software
c. Bandsaw machine
d. Milling Machine
e. Grinding Machine
f. Welding Machine
g. Drilling Machine
h. Measuring Tools
i. Stationery
j. S45C Steel (Medium Carbon Steel)

2.2. Fabrication of Flipper Mold Tool

Carrying out the fabrication of the flipper mold tool, the work process includes several stages of work, including:

a. Printing Work Drawings

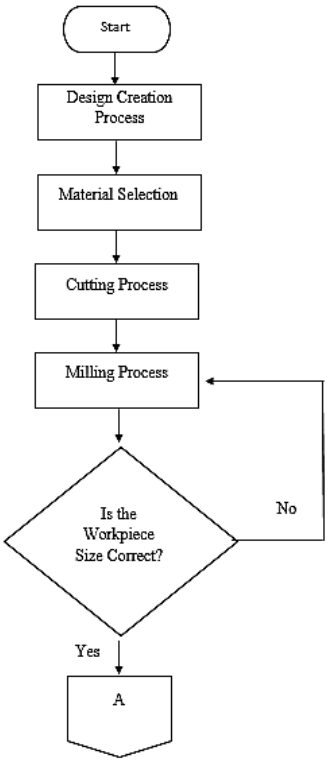

Figure 1. Printing work drawing

Working drawings have been made in advance before carrying out the work, in order to avoid errors that will arise when working on the workpiece. Working on work drawings is done during the practical work process. The unit of length used is mm.

b. Cutting Plates

Cutting plates based on existing work drawings, using a bandsaw machine. Here are the various forms of plate pieces that will be cut.

c. Drilling bolt holes

This flipper mold tool that is made can be disassembled. Therefore it will be assembled using bolts for assembly later. Namely to make it easier and more efficient when stored.

d. Workpiece welding

The material plate of the flipper mold tool that has been cut according to the working drawing, will be continued with welding to unite the parts that are assembled by welding.

2.3. Assembly of the flipper mold tool

This flipper mold tool is deliberately made to be disassembled to facilitate mobilization or change places if needed. To assemble the flipper mold tool there are several steps that must be done including:

1) Prepare the wheel train as a mold holder.
2) Install the top support on the wheel holder.
3) Connect the upper support with the inner flipper holder.
4) Install the outer flipper holder with the support.
5) Attach the base to the inner flipper holder.
6) Install the flipper clamp on the base and adjust according to the mold size.
7) And the flipper mold assembly has been completed.

Figure 2. Flipper molding tool that has been fabricated

2.4 Research Flowchart

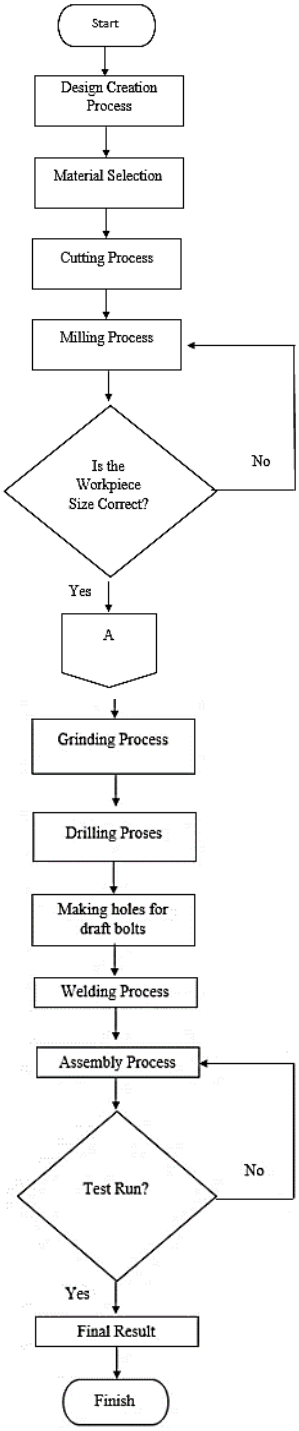

Figure 3. Research flowchart

The flowchart of the planning and manufacturing process in Figure 3 begins with a literature study. The literature study aims to find and collect references or materials related to the process of making flipper clamp molds. References collected come from journals, books and sources from the internet. The next step is the process

of making a flipper mold design. This process aims to design the shape of the flipper mold.

The next step is the selection of tools and materials. This step aims to find materials that match the criteria of the tool to be made and choose the most suitable material for certain applications in engineering. The selection is made based on criteria such as mechanical properties, physical attributes, cost, availability, and sustainability. After completing the purchase of tools and materials, the tool manufacturing will be carried out.

The manufacture of the tool is carried out in accordance with the size specified in the design. If it is not appropriate, the calculation and design will be carried out again and make the tool design again. But if it is in accordance with the calculation and design, the next step can be done, namely the grinding process, the driling process to the assembly process. The final stage is testing a tool whether it functions according to plan or not. If according to the plan, it will continue at the stage of making the final result report.

3. Result and Discussion

The novelty of this research is the mechanism in the maintenance / repair mold that has existed before is to lift the mold using a forklift and then put it on a cart for the mold in the production area, then taken to the workshop, in the workshop the mold is allowed to stand first because of its high temperature, then moved to the table and the pallet is flipped manually by two operators. With this Flipper Clamping tool, it is hoped that it can make it easier for operators in mold

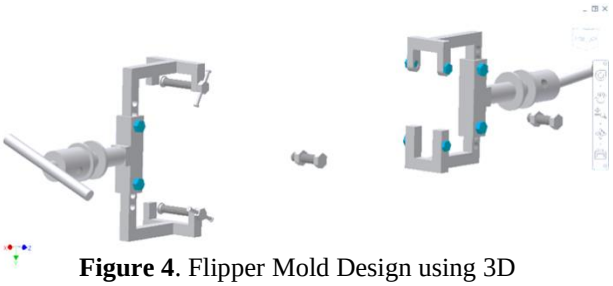

Figure 4. Flipper Mold Design using 3D Autodesk Inventor Software

maintenance and repair, because the previous mechanism requires two operators to flip molds that weigh more than 200 kg, now they only need to flip by turning the lever of this tool.

3.1 Material Selection

The materials selection process refers to the process of identifying and selecting the most suitable material for a particular application in engineering. Selection is based on criteria such as mechanical properties, physical attributes, cost, availability, and sustainability.

Figure 5. Material S45C

In the process of making Flipper Mold tools at PT XYZ using S45C steel type material is a type of "Medium Carbon Steel" steel. With this medium carbon content, it allows this steel to improve its mechanical properties. S45C steel has a tensile strength of 452.75 N/mm2. The smallest diameter of the lever from the Inner Flipper Holder is 25 mm or has an area of 490.625 mm2. This means that the inner flipper holder can withstand a tensile load of 22,652.51 Kg. So S45C is very powerful and safe to choose. Suitable for application to flipper molds that require strength and impact resistance of components, due to high carbon content, therefore, having higher tensile strength, flexibility, and wear resistance.

3.2 Cutting Process

Raw materials that have been measured using measuring instruments and marked using markers are then cut using a horizontal bandsaw machine one by one. Plate cutting based on existing work drawings, using a bandsaw machine. Here are the various forms of plate pieces to be cut.

Figure 6. Workpiece cutting

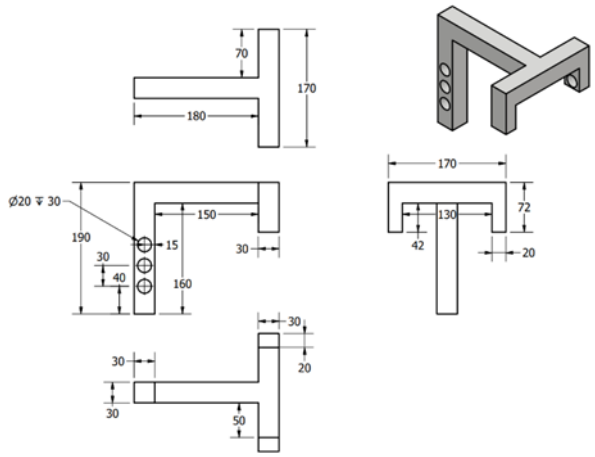

Figure 7. Flipper adjuster clamping

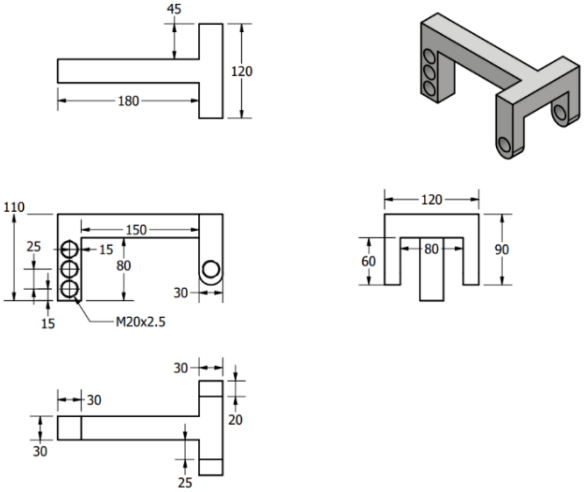

Figure 8. Locking flipper clamp rods 2 pcs

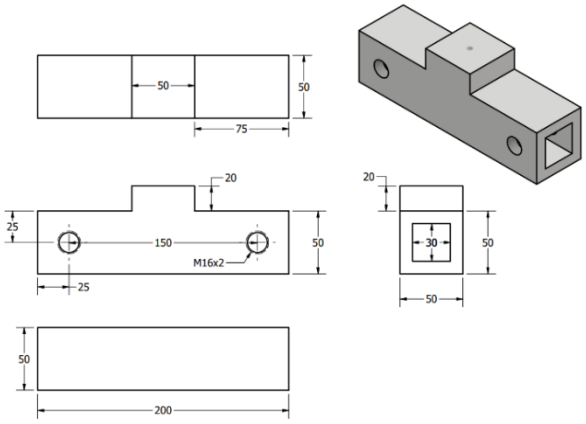

Figure 9. Base flipper clamps 2 pcs

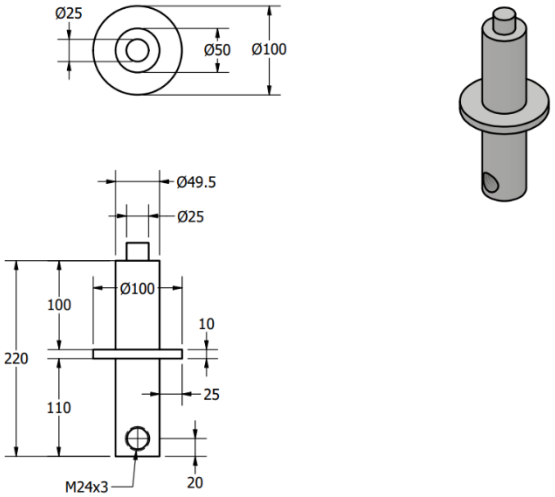

Figure 10. Inner flipper holder 2 pcs

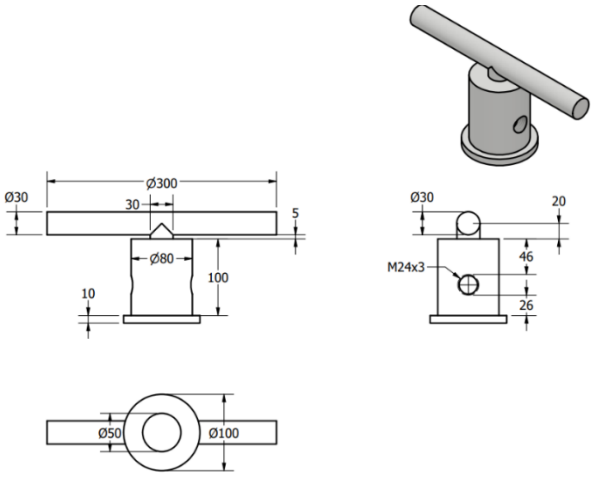

Figure 11. Outer flipper holder 2 pcs

Figure 12. Material ready for shaping

Working steps for using a bandsaw machine:

1) Check that the machine is in normal condition with no tags indicating abnormality.
2) Make sure the machine is off and ready to use.
3) Open the machine collar to clamp the workpiece, then tighten the collar so that the workpiece does not move.

4) Make sure the workpiece is ready to be cut, no abnormal objects are around the workpiece.
5) Then turn the red stop button, wait until the indicator light lights up indicating the machine is on.
6) Press the on button to run the machine, wait until the machine starts.
7) Turn the water spray button so that the workpiece and saw blade but at a low temperature.
8) Then turn the hydraulic button to lower the blade slowly until the blade hits the workpiece until it is cut.
9) When the cutting process is complete, turn off the machine and do the reverse.

3.3 Milling Process

The material that has been cut in the bandsaw machine is then blocked / adjusted in the milling machine according to the size in the technical drawing, because if cutting only using a bandsaw machine there will be a large enough tolerance between the workpiece and the size in the technical drawing [12].

Figure 13. Milling process

Working steps for using the milling machine:

1) Check if the vise is in good condition and try to position the vise in the middle of the machine table.
2) Insert and tighten one of the fastening bolts so that the position of the vise does not change.
3) Place the dial indicator, attach the parallel to the mouth of the vise then touch the dial indicator sensor with the parallel side.
4) Move the machine table. When the needle on the dial indicator moves, hit the vise little by little.
5) If the needle on the dial indicator shows the same number, tighten the two bolts that fasten the vise.
6) Place the workpiece on the mouth of the vise and tighten the vise little by little while the workpiece is hit so that it sits right on the support.
7) Install the arbor on the machine spindle and install the milling knife on the arbor, adjust the arbor pegs, insert the locking bolts and tighten until firm.
8) Touch the workpiece to the tip of the rotating milling blade and set the main spindle scale at zero.
9) Turn on the main button of the milling machine and set the engine rotation speed according to the size of the knife and the type of material being cut.
10) Setting the workpiece at the zero-scale position.
11) Start the machine and move the table to start the cutting process.
12) Measure the results of the incision according to the desired size.

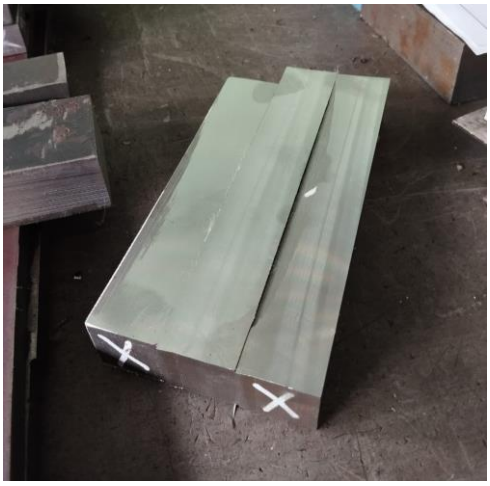

Figure 14. Workpiece result from milling process

3.4 Grinding Process

Grinding is a manufacturing process that involves the use of abrasive wheels or grinding stones to remove material from the surface of a workpiece. The main purpose of grinding is to achieve precise dimensions, surface smoothness, and the desired geometry shape [13].

Figure 15. Comparison after grinding

The function of the grinding process on this flipper mold workpiece is to smooth the surface of the workpiece that has been cut on the bandsaw and milling machines mentioned above [14].

Working steps for using the grinding machine:

1) Make sure the grinding machine is normal and in the off position.
2) Check the grinding eye or grinding stone whether it is worn or not.
3) Use appropriate PPE such as goggles, apron, and 3M mask to prevent iron grams from injuring workers.
4) Prepare the workpiece, and make sure there are no objects blocking the grinding stone from rotating.
5) Turn or press the button to turn on the grinding machine.
6) Hold the workpiece firmly and bring the workpiece close to the grinding stone slowly and carefully.
7) Measure the cutting result according to the desired size.

3.5 Drilling Process

Drilling is a machining process for making round holes in workpieces. Drilling is usually done using a cylindrical tool that has two cutting edges called a drill, in this case the workpiece that is already the right size, is punched and drilled for bolts, so that it is stronger when lifting a mold that weighs more than 300 kg [15].

Working steps of using drilling machine:

1. Make sure the machine is in normal condition and there are no suspicious objects around the vise table.
2. Turn on the on button then the spindle rotates, which is driven by the motor.
3. Since the radial arm can move up and down in the column, the radial arm is adjusted according to the operation and height of the workpiece.
4. The spindle is fixed on the chuck, and the drill bit is placed in the jaws of the chuck.
5. Adjust the position of the drilling machine head so that the tool is in the right position to make a hole in the workpiece.
6. Once positioned properly, the drill bit is easily moved to the workpiece. Because the drive mechanism used in the drilling machine is a rack and pinion mechanism.
7. Gears are used to convert rotation into linear motion. When the handwheel is rotated, the pinion attached to the rack also rotates, which will convert the rotation into linear motion so that the drill bit moves towards the workpiece.
8. When finished, turn off the drilling machine.

3.6 Welding Process

Welding is a metal joining technique by partially melting the parent metal and filler metal with or without metal enhancers and producing a continuous metal [16]. The welding used is Tig Welding or Tungsten Inert Gas is welding that uses tungsten electrodes and inert protective gases such as argon. The function of the welding process in this case is to connect the raw materials that have been cut and adjusted in size to become several parts, namely the Base, Flipper Clamps, Flipper Holder and carriage holder which later these parts will be put together in the assembly process.

TIG welding, or Tungsten Inert Gas, is a welding method that uses a tungsten electrode and an inert shielding gas such as argon [17] Here are the general work steps for using TIG welding:

1. Prepare the equipment, make sure you have a suitable TIG welding machine that is in good condition.
2. Prepare an argon shielding gas cylinder and make sure the pressure is sufficient.
3. Prepare tungsten electrodes that match the type of metal to be welded.
4. Prepare the material, make sure the surface of the material to be welded is clean of dirt, oxide, and oil and then prepare the material by securing and arranging it as needed.
5. Set the TIG welding machine parameters, such as current (amperage), voltage, and gas flow rate, do not forget to adjust the settings according to the thickness of the material to be welded.
6. Select a tungsten electrode that is suitable for the application and type of metal and designate the electrode tip according to the needs (blunt, taper, etc.). if we use a taper tip so that welding can be neat and detailed. and don't forget to make sure the electrode is clean and free of contamination.
7. Wear safety equipment for eye protection, hands, and appropriate clothing and ensure the workspace is well ventilated.
8. When starting welding move the electrode in a slow and controlled manner according to the desired design or pattern.
9. After finishing welding, turn off the welding machine and let the material cool down, then check the welding results and make sure the quality meets the standards.
10. Clean the remnants of the electrode, welding material, and surrounding area.

3.7 Assembly Process

The assembly process is the culmination of all the processes that have been passed from starting the design until the workpiece is completed [18] . In this process all plates will be assembled in accordance with the sequence as designed in the design process, but this Flipper Mold is still in the development stage and cannot be used properly because it requires modifications to the mold transport cart as an arm to connect the flipper mold to the mold, due to limited use of tools, machines and time given.

4. Conclusions

Based on the results of the research conducted, it is found that the material used in the work is Carbon Steel (S45C). The process of making Flipper Clamps Mold has several stages, namely the Design Making Process, Material Selection Process, Cutting Process, Milling Process, Grinding Process, Drilling Process, Welding Process, and Assembly Process. This research is still in the development stage because it requires careful design for modifications to the mold holder carriage, the intended modification is intended as a carriage arm to hold the flipper holder. This research is in the development stage due to the limited use of tools, machines and time in conducting this research, where this research is the second project carried out and carried out in a period of approximately 2 months.

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References

[1] B. Irawan, P. Septaningrum, I. Wijayanti, R. Hakim, and I. Saputra, ‘Perancangan Dan Modifikasi Mold Insert untuk Meningkatkan Kapasitas Produksi Light Guide’, *J. Rekayasa Mesin*, vol. 14, pp. 927–938, Dec. 2023, doi: 10.21776/jrm.v14i3.1457.

[2] I. Azis, ‘Analisis Penyebab Dan Pencegahan Grid Corrosion Lead-Acid Battery Pada Plat Positive’, ITS Surabaya, 2017, pp. 43–44.

[3] A. Damuri and D. Pernata, ‘Perancangan Sistem Informasi Perawatan Mold Dan Mesin Injection Molding Pada PT Hirose Electric Indonesia Menggunakan PHP Dan MySQL’, *J. Ilm. MIKA AMIK Al Muslim*, vol. 4, no. 1, Art. no. 1, May 2020, Accessed: Aug. 29, 2024. [Online]. Available: https://journal.almuslim.ac.id/index.php/mika/article/view/25

[4] B. H. Irawan and H. T. A. Siburian, ‘Perencanaan Penjadwalan Preventive dan Proactive Maintenance Pada Dies Molding Capacitor’, *J. Teknol. Dan Ris. Terap. JATRA*, vol. 2, no. 1, Art. no. 1, Jun. 2020, doi: 10.30871/jatra.v2i1.2046.

[5] H. A. Munawi, M. H. Alwi, A. P. Nevita, R. Santoso, and E. M. Indrawati, ‘Alat Pengendali Stop Kontak Berbasis Wemos D1’, *G-Tech J. Teknol. Terap.*, vol. 7, no. 1, pp. 29–36, Jan. 2023, doi: 10.33379/gtech.v7i1.1823.

[6] M. Junaidi, R. Sandora, and Budianto, ‘Implementasi Lean Manufacturing Guna Meningkatkan Efisiensi pada Devisi Manufacturing Departemen Mold di PT. Manufaktur Mold’, *Proc. Conf. Des. Manuf. Eng. Its Appl.*, vol. 1, no. 1, Art. no. 1, 2017.

[7] B. W. Febriantoko, A. Aryanto, and T. W. B. Riyadi, ‘Rancang Bangun Mold untuk Proses Termoforming Prosthetic Below Knee (B/K)’, *Media Mesin Maj. Tek. Mesin*, vol. 18, no. 2, Art. no. 2, Oct. 2017, doi: 10.23917/mesin.v18i2.5243.

[8] D. Jerry, C. Okechukwu, C. Nwaeju, J. Abutu, and R. Akinode, ‘Development and Evaluation of Mild Steel Permanent Mould for Al- Alloys Pulley Production’, vol. 11, pp. 181–191, Aug. 2024.

[9] J. N. Wijaya, *Rancang Bangun Alat Mesin Plastik Injection Molding*. Universitas Diponegoro, 2022.

[10] M. H. Parapat, *Analisis Penyebab dan Pencegahan Terjadinya Short Circuit pada Aki ITZ 5 S Volcano (Studi Kasus : PT. Indobatt Industri Permai*. ITS Surabaya, 2015.

[11] U. Wahyudi, ‘Pengaruh Injection Time dan Backpressure Terhadap Cacat Penyusutan Pada Produk Kemasan Toples dengan Injection Molding Menggunakan Material Polistyrene’, *J. Tek. Mesin*, vol. 4, p. 15, Mar. 2017, doi: 10.22441/jtm.v4i3.1269.

[12] H. H. Azwir, N. C. Wijaya, and H. Oemar, ‘Implementasi Metode Single Minute Exchange Of Die Untuk Mengurangi Waktu Persiapan dan Penyesuaian Mold di Industri Polimer’, *JISI J. Integrasi Sist. Ind.*, vol. 8, no. 2, Art. no. 2, Sep. 2021, doi: 10.24853/jisi.8.2.41-52.

[13] H. M. Robinson, S. Hariadi, and A. Ridwan, ‘Modifikasi Alat Bantu Kerja Repair Mold Tire dengan Metode Kaizen Dapat Meningkatkan Produktivitas PT. Gajah Tunggal Tbk’.

[14] S. Sisworo and S. Mulyati, ‘Preventive Maintenance Mold Reflector Rg 100 Untuk Mengurangi Persentase Defect Produk Reflector RG 100 Hasil Proses UV Coating Pada PT. Arisamandiri Pratama’, *J. Rekayasa Mesin*, vol. 12, no. 3, Art. no. 3, Dec. 2017, doi: 10.32497/rm.v12i3.1072.

[15] Mukhlis - and B. D. Haripriadi, ‘Analisa Pengaruh Variasi Parameter Gurdi (Drilling) Dan Pendingin Terhadap Burr Formation Hasil Pemesinan Cnc Routermilling Pada Aluminium Sheet 1100’, *J. Rekayasa Mater. Manufaktur Dan Energi*, vol. 3, no. 2, Art. no. 2, Sep. 2020, doi: 10.30596/rmme.v3i2.5276.

[16] P. Kurniawan, A. Iswantoko, F. Lado, and H. Prasetyo, ‘Simulasi Distribusi Temperatur Equivalent Von Misses dan Heat Flux Pada Pinless Friction Welding’, *SINERGI POLMED J. Ilm. Tek. Mesin*, vol. 5, pp. 102–107, Mar. 2024, doi: 10.51510/sinergipolmed.v5i1.1544.

[17] W. Zhu, J. Yang, Y. Xi, and Z. Nie, ‘Welding performance of several TIG tungsten electrodes’, *Xiyou JinshuChinese J. Rare Met.*, vol. 38, pp. 793–799, Sep. 2014, doi: 10.13373/j.cnki.cjrm.2014.05.009.

[18] R. Parzeller, D. Koziol, T. Dagner, and D. Gerhard, ‘Automating the assembly planning process to enable design for assembly using reinforcement learning’, *Proc. Des. Soc.*, vol. 4, pp. 2179–2186, May 2024, doi: 10.1017/pds.2024.220.