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DESIGN AND BUILD OF 1 (ONE) AXIS PLASMA CUTTING MECHANISM

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Abstract. Plasma cutting is a cutting process that is widely used by the metal industry and individuals. Plasma cutting is widely used because it has many advantages, including: Cheap tools and widely sold in the market, low operating costs because they use electric power and compressed air from a compressor, unlike oxyacetylene cutting which requires oxygen, the available tools are more flexible and easy moved.

The use of plasma cutting is relatively easy, by setting the machine and then directing the plasma torch to the cutting plane as needed by maintaining a stable movement and height. However, when we are going to make repeated cuts, our concentration and physical power will automatically decrease, so we need a tool that can assist us in directing/regulating the plasma in which the tool functions as a plasma cutting mechanism.

Based on this background, the author made a 1 axis plasma cutting torch rail mechanism which is driven by an electric motor, this tool has a workspace/cutting length of 1300 mm, with tool sizes Length, width and height 1950 mm x 300mm x 100 mm. This mechanism/tool can be installed on torches of several brands of plasma cutting, with various bracket speeds that can be adjusted as needed depending on the thickness of the plate being cut, from cutting speeds of 300 mm/minute to 2,000 mm/minute, adjustable cutting height 0 mm up to 10 mm, with a cutting angle setting of 0o to 90o and this mechanism tool can also be used portable / can be moved according to the required work location. Plasma cutting mechanism can be used to make it easier to make straight/horizontal cuts.

Keywords: design, plasma cutting, mechanism.

1. INTRODUCTION

Plasma cutting is a metal cutting process that is widely used by the metal industry and individuals. Plasma cutting is widely used because it has many advantages, including: Cheap tools and widely sold in the market, low operating costs because they use electricity and compressed air from a compressor, unlike oxyacetylene cutting which requires oxygen, the available tools are more flexible and easy moved. Plasma gas is compressed air, nitrogen, oxygen or argon/hydrogen for cutting mild and high alloy steel, aluminum, copper and other metals and alloys [1]. The quality characteristics assessed include surface roughness, zone of heat influence and geometrical consistency of the cut. Using the experimental design and analysis of variance, it was found that the surface roughness and consistency are mainly affected by the cutting height, while the heat-affected zone is mainly affected by the cutting current [2]

The plasma process is suitable for electrically conducting materials with thicknesses from 1 to 600 mm. The plasma cutting process can be used to cut any conductive material, including carbon steel, stainless steel, aluminum, copper, brass, cast metals, and exotic alloys [3]. The quality characteristics assessed include surface roughness, zone of heat influence and geometrical consistency of the cut. Using the experimental design and analysis of variance, it was found that the surface roughness and consistency are mainly affected by the cutting height, while the heat-affected zone is mainly affected by the cutting current [4]. Plasma cutting, whether conventional or precision, is a fast and economical way to manufacture parts. Manufacturers must first understand the process, and then determine whether this process or another process produces parts more effectively [5].

The use of plasma cutting is relatively easy, namely by setting the machine and then directing the plasma torch to the cutting plane as needed by maintaining a stable movement and height. However, when we make repeated cuts, our concentration and physical strength will automatically decrease, so we need a tool that can help us direct/adjust the plasma torch, which is called a plasma cutting mechanism.

The lower the torch distance used, the smaller the value of the kerf width and surface roughness produced [6]. The results showed that the lower the rate of decline, the higher the hardness value and vice versa [7].

Based on this background and also looking at a simple plasma mechanism making motorized plasma cutting track [8], the previous author designed a 1-axis plasma cutting torch rail mechanism driven by a motor, where the rail movement speed and the height of the torch with cutting materials can be set to [9], the author has previously designed a 1 axis plasma cutting torch rail mechanism that is driven by an electric motor, where the speed of the rail movement and the height of the torch with the cutting material can be adjusted to [9], and now the author will realize the design by making a plasma cutting mechanism of 1 (one) Axis.

The objectives of the manufacture of mechanical tools are: 1. with the success of making this tool, it is hoped that it can make a useful contribution to the Workshop in increasing the effectiveness and time efficiency of metal cutting; 2. make it easier to make certain shapes and cut straight objects.

2. METHODS

Design is a process that consists of several stages, and these stages require a process that is not short. According to Booker, design is a process of simulating what we want to make before we make it, over and over again so that we can be satisfied with the final result [10]. In addition, the design aims to create better results (objects) than before. Design is a creative activity, involving a process to bring to something new and useful that was not previously there [11], and design is the main proposal that changes something that already exists into something better, through three processes: identifying problems, identify methods for problem solving, and implementation of problem solving. In other words, it is programming, drafting, and implementing plans [12]. Design is the making of a model of a tool (prototype) or a creation of something that has a physical reality. Making a tool requires planning the components that will be used to meet the needs of the mechanism of the tool being made. Strength is a consideration in building a tool, where strength depends on the selection, treatment and workmanship carried out on the material [13] which will be carried out is applied research, which is based on a problem.

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Activities planning or designing a construction must consider several criteria including the following:

- Easy and simple, easy to manufacture or common components on the market.
- Economical is an action/behavior where we can obtain inputs (goods or services) that have the best quality at the lowest possible price level.
- Aesthetics is a feeling that arises from how beautiful or charming an object is seen and the tool must be aesthetically pleasing in appearance and form.
- Appropriate, is a technology that is invented or invented or created with the aim of improving or making human work more smoothly. This can then increase the economic value as well, the technology is not only made but made precisely according to human needs

Machine elements are very often made of either metal or metal alloys such as steel, aluminum, cast iron, zinc, titanium or bronze. This section describes the important properties of materials that can affect the mechanical design [15].

Strength, elasticity and ductility properties for metals, plastics and other types of materials are usually determined from a tensile test in which a sample of the material, which is usually circular or flat rod, is clamped between clamps and pulled gently until it breaks. The magnitude of the force on the bar and the change in length (strain) are monitored and recorded continuously throughout the test. Since the stress in the rod is equal to the force acting on the rod divided by the area, the stress is proportional to the force acting on the rod.

The things that must be considered in the selection of materials for the design are as follows:

1. Hardness

   The resistance of a material to indentation by a penetrator is an indication of its hardness [15]. Several types of tools, procedures, and penetrators for measuring the hardness of the Brinell hardness tester and the Rockwell hardness tester are most commonly used for machine elements. For steel, the Brinell hardness tester uses a 10 mm diameter hardened steel ball as a penetrator with a load of 300 kg of force. The load causes permanent indentation in the test material, and the diameter of the indentation is associated with the Brinell hardness number, which is abbreviated as BHN or HB.

The actual quantity measured is the load divided by the area of the indentation box. For steels, HB values range from about 100 for annealed low carbon steels to more than 700 for as-quenched high-alloy steels. In the high range, above HB 500, penetrators are sometimes made of tungsten carbide instead of steel. For the softer metals, a load of 500 kg is used.

2. Strength

The ability of a material to withstand stress without breaking. Or the ability of a material to accept a load, the greater the load that can be received by the material, the object can be said to have high strength.

3. Brittleness

Refers to the nature of metal that is easy to crack or break when subjected to impact forces on it. An example of a brittle product is a machine frame made of gray cast iron. The brittleness property was tested using a charpy testing machine.

Steel Steel is a metal alloy between iron (Fe) and carbon (C), where iron is the basic element and carbon is the main alloying element. The carbon content in steel is less than 1.4% by weight according to its grade. In the steel-making process there will be other elements besides carbon that will be left in the steel such as manganese (Mn), silicon (Si), chromium (Cr), vanadium (V), and other elements. In terms of application, steel is often used as a raw material for tools, agricultural implements, automotive components, household needs. Steel can be classified based on chemical composition such as carbon content and alloy used [16].

The working principle of an electric motor is to convert electrical energy into mechanical energy. This change occurs by converting electric power into a magnet or called an electromagnet, then the result is a set of rotating fields around the stator. A conductor located in a moving magnetic field will have a current induced in it and a force will be exerted perpendicular to the conductor. This force acts around the rotor to create a torque which will rotate the rotor [16].

The shaft is a rotating part, which is attached to the force transfer elements, such as gears, and bearings. Shafts can accept tensile, flexural, compressive or torsional loads acting alone or in combination with one another. The word shaft includes several variations such as shaft or axle. Shaft is a shaft that rotates and receives torsional loads [17].

Another type of shaft is the transmission shaft type. This shaft will transmit power including clutch, gear, pulley, belt or chain sprocket and others. This type of shaft obtains pure torsional or torsional and bending loads. Large power may be required at start or a large load may continue to operate after starting. Thus, it is often necessary to correct the required average power using a planning correction factor of [18].

3. RESULTS AND DISCUSSION

Design and construction of plasma cutting mechanism 1 (one) Axis has a sliding type movement concept, which uses a sliding axle/groove consisting of 2 pieces and a sliding bearing connected to a plasma cutting torch bracket/holder as shown in Figure 1 [9].

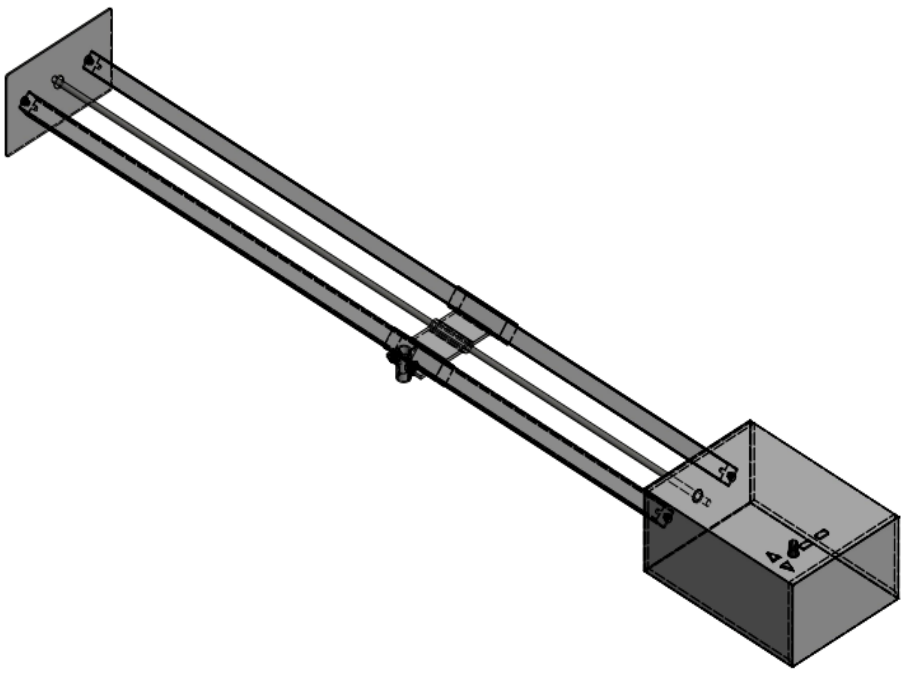

Figure 1. Design of 1 (one) axis plasma cutting torch rail mechanism [9]

This machine has several parts as shown in Figures 2 and 3;

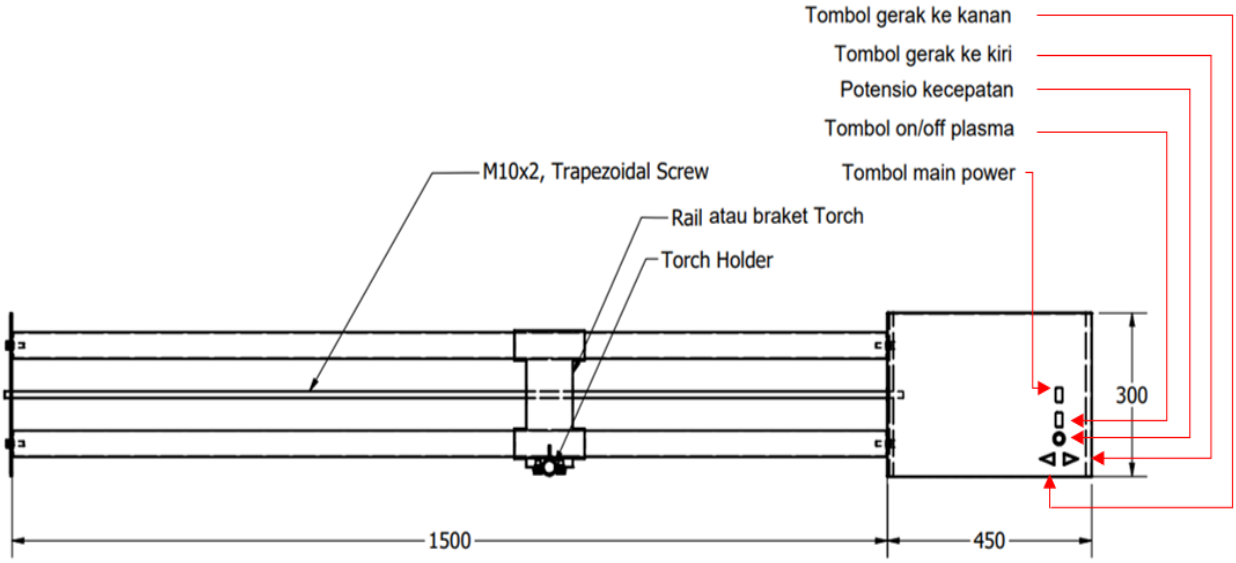

Figure 2. Description of the top view component [9]

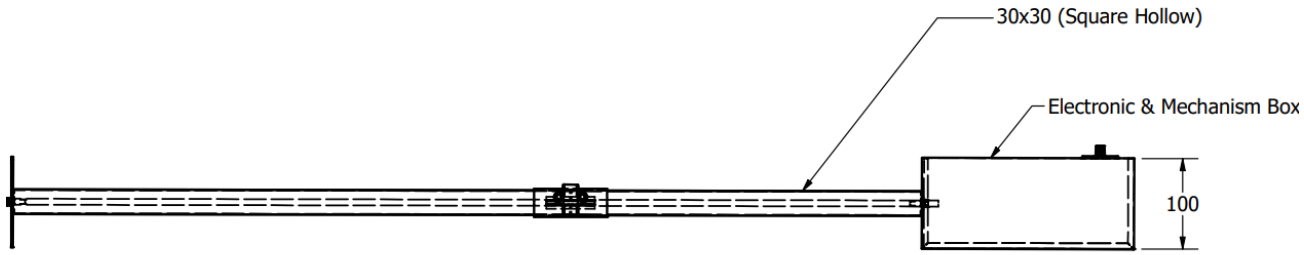

Figure 3. Description of front view components [9]

Tools and materials used in the manufacture of the main frame: electric welding machine, hand grinder, hammer, cleaning brush, elbow, ruler roll, steel ruler, scraper, pin, Rail consists of 2 pieces of hollow iron measuring 30 mm x 30 mm which arranged parallel and arranged on a body made of 10 mm thick iron plate, in the middle of the iron there is a threaded axle which is used as a medium for the successor/driver of the torch bracket which is powered by an electric motor as shown in Figures 2 and 3. The rail is only made of 1 (one) axis and bracket can move back and forth. Cut the parts according to the working drawings. After cutting, proceed with spot welding first for the manufacture of the left end frame and the middle and right end frames. After the frame is in accordance with the size that has been set, then do the welding of all parts permanently. For sharp welding parts, do grinding in addition to grinding safety, it also serves to increase the value of neatness on the tool. The holes in the frame are drilled with a hand drill according to the part to be installed on the frame.

The bracket is made of holo molded iron, plate and molded plate for plasma torch mount. The movement of the bracket is powered by a 12 volt DC motor, which is threaded to drive the bracket. The torch holder on the bracket on the bracket can be adjusted, the position of the plasma cutting torch can be adjusted in height and also the angle as needed so that apart from being able to be used for straight cuts, this mechanism can also be used to cut corners.

The threads are mounted on the frame with bearing bases and connected to the motor. Tools and materials used in the manufacture of electric motor mounts include: electric welding machines, elbows, hammers, cleaning brushes, hand grinders, hand drills, scrapers, pins, steel rulers, 1 mm thick iron plate. The process includes cutting using a hand grinder carefully in order to get maximum results and to maintain safety while working. Make holes for the placement of the electric motor and also make holes for the bolts. The source of motor power can be generated from PLN electrical energy which is converted to 12 volts by an inverter. The speed of the motor movement is regulated by a 12 volt potentio, so that the movement of the bracket can be adjusted as needed. Movement to the right/left of the motor is regulated by a 12 volt DC relay circuit and 2 (two) buttons.

1 (one) main switch is prepared as a main power regulator, 1 (one) switch is made as the on/off plasma cutting, which is connected to the plasma machine circuit and is arranged as the jack and receiver on the plasma

machine.

In this step, it is explained about the assembly of each component that has been made previously. Before carrying out the component assembly process, do the painting on the machine components you want to paint first. The assembly steps are:

a. Install the pillow block first on the frame according to the working drawings, then insert the bracket driver into the bearing, then tighten the screw holder for the threaded shaft on the bearing as shown in Figure 4.

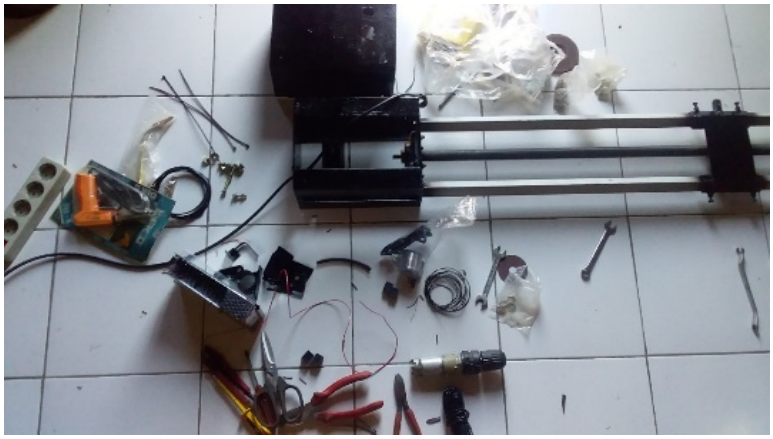

Figure 4. Assembly of components, bracket rails, frame, drive screw shaft, bracket

b. Attach the rails to the frame as well as the threaded shaft, along with the torch bracket.
c. Mount the motor on the frame and connect the ends to the threaded shaft.
d. Install the switches on the cover, then attach the frame to the cover as shown in figure 5

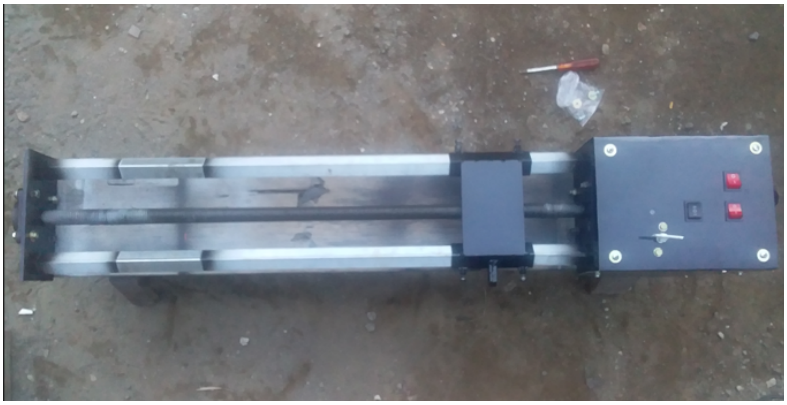

Figure 5. Installation of the power switch and motor speed regulation

e. Check all components that have been installed and check the tightness of the bolts and nuts that are still not strong.
f. Check all electrical installations before turning it on as shown in Figure 6

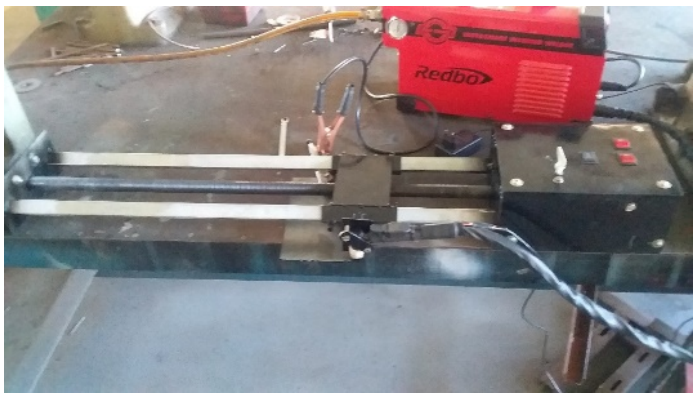

Figure 6. Re-checking the electrical installation before trying it

After the tool components have been assembled, then the tool testing is carried out to determine the capabilities of the designed tool (see Figure 1). The test was carried out 5 times, by trying to use plasma cutting to cut a 10 mm plate with a ready-made mechanism as shown in Figure 7.

Figure 7. Testing of 1 axis plasma cutting mechanism

In this test, the minimum speed of the bracket movement is also tested, which is 300 mm/min and a maximum of 2,000 mm/min.

Every equipment requires maintenance to ensure the tool works according to standards and is ready for use. The maintenance carried out on the 1 (one) Axis plasma cutting mechanism is as follows:

a. Preventive Maintenance

Maintenance activities carried out to avoid equipment failure, such as:

1) Make sure the electric motor is in good condition and does not make noise.
2) The condition of the bracket rails is lubricated, so that the movement of the bracket can be carried out properly.
3) Clean the tool after use.
4) Always lubricate bearings for maximum life.

b. Corrective Maintenance (Corrective Maintenance)

Maintenance activities are carried out to restore the function of the tool in a condition that is suitable for reuse, such as:

1) Perform replacement if the electric motor is damaged.
2) Perform bearing replacements.
3) Unplanned maintenance

Are maintenance activities that must be carried out immediately after a malfunction or sudden damage occurs, such as:

1) Replacement on the electric motor.
2) Torch holder replacement
3) Replacement of short-circuited and burnt cables.

4. CONCLUSION

From the description, manufacture of tools and testing of 1 (one) axis plasma cutting mechanism, the following conclusions can be drawn:

a. The dimensions of the plasma cutting mechanism are 1 (one) axis, namely with a workspace/cutting length of 1300 mm, with tool sizes Length, width and height 1950 mm x 300mm x 100 mm
b. The 1 (one) axis plasma cutting torch rail mechanism can be installed on the torch of several brands of plasma cutting machines, with various bracket speeds that can be adjusted as needed depending on the thickness of the plate being cut, from cutting speeds of 300 mm/minute to 2,000 mm/ minutes, the cutting height can be adjusted from 0 mm to 10 mm, with the cutting angle setting 0o to 90o and this mechanism can also be used portable / can be moved according to the required work location.
c. Plasma cutting mechanism can be used to make it easier to make straight/horizontal cuts.

5. ACKNOWLEDGEMENT

Finally, I would like to thank everybody who was important to the successful realization of this paper. This paper is far from perfect, but it is expected that it will be useful not only for the researcher, but also for the readers. For this reason, constructive thoughtfull suggestion and critics are welcomed.

6. REFERENCES

[1] Azian Diki dkk . 2021. Identifikasi Hasil Pemotongan Plasma Cutting Dengan Variasi Travel Speed : Jurnal Politeknik Negeri Batam;
[2] K. Salonitis and S. Vatousianos,(2012). Experimental investigation of the plasma arc cutting process, Manufacturing and Materials Department, Cranfield University.
[3] Experimental Results Concerning The Variation Of Surface Roughness Parameter (Ra) At Plasma Arc Cutting Of A Stainless Steel Workpiece Sanda-Maria Ilii
[4] Asiabanpour Bahram (2009) Optimising the automated plasma cutting process by design of experiments. Int. J. Rapid Manufacturing, Vol. 1, No. 1, 2009.
[5] Hatala Michal Faculty of Manufacturing Technologies of the Technical University of Košice Štúrova The Principle of Plasma Cutting Technology and Six Fold Plasma Cutting. 5 th International Multidisciplinary Conference
[6] Fathony Nada Saputro dan Wirawan Sumbodo. 2019. Pengaruh ketinggian torch terhadap lebar kerf dan kekasaran permukaan pada pemotongan cnc plasma arc cutting dengan bahan baja ST 37. Semarang : Jurnal Kompetensi Teknik Vol. 11, No.2, November 2019;
[7] Ami Rima Rahmawati dkk. 2019. Pengaruh kecepatan pemotongan dan ketebalan bahan terhadap kekerasan dan kekasaran permukaan baja AISI 1045 menggunakan cnc plasma arc cutting. Semarang : Jurnal Dinamika Vokasional Teknik Mesin. Volume 4 Nomor 2 Oktober 2019 Hal 93-98;
[8] Darek and Sebastian, 2018, youtube.com/watch?v=V0ahzDSYDxo, Poland
[9] Suma Wibawa I Wayan dkk. 2022. Perancangan mekanisme rel torch plasma cutting 1 (satu) Axis. Badung : Journal of Applied Mechanical Engineering and Green Technology. Vol. 3 No. 1 (2022): March 2022
[10] Booker, P.J, 1962, Principles and Precedents Engineering Design, London, Institution of Engineering Designers
[11] Reswick, J.B, 1965, Prospectus for an Engineering Design Center, Cleveland OH, Case Institute of Technology
[12] Wade, J.W, 1977, Architecture, problems, and purposes: Architectural design as a basic problem-solving process, Wisconsin, London, John Wiley & sons pub
[13] Akhmad, Al. Antoni. 2009. Pemesinan nonkonvensional plasma arc cutting. Palembang : Jurnal Rekayasa Mesin. Vol. 9, No.2 : 51–55;
[14]G. Rosnani, “Perancangan Produk. Graha Ilmu”, Edisi 10. Yogyakarta-Indonesia, 2010
[15] R.L. Mott, “Elemen-Elemen Mesin Dalam Perancangan Mekanis”, Edisi 1. Penerbit Andi. Yogyakarta-Indonesia, 2004.
[16] T. Surdia, dan S. Saito, “Pengetahuan Bahan Teknik”, Edisi 3. PT. Pradnya Paramita. Jakarta-Indonesia, 1985.
[17] R.S. Khurmi, dan J.K. Gupta, “Text Book of Machine Design Eurasia”, Edisi 1. House ltd Ram Nagar, New Delhi-India, 2005.
[18] Sularso dan K. Suga, “Dasar Perencanaan Dan Pemilihan Elemen Mesin”, Edisi 1. Pradnya Paramita. Jakarta-Indonesia, 2002.