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Sustainability design of press machine for waste plastic bottle with electric motor

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Abstract. Waste plastic bottle can be a pollutant that can damage the environment. If this waste plastic bottle is not well controlled, it will certainly harm the sustainability of other ecosystems. Usually, waste plastic bottle is difficult to decompose naturally, and even if it will be decomposed, it will take a long time, from 100 to 500 years. The main source of waste plastic bottle is usually the use of plastic material itself, which it is used to inseparable support in everyday life. In general, the use of plastic material has several considerations such as: lightweight, corrosion resistance, non-toxicity, friction and impact resistance, chemical resistance, good thermal stability, and good insulation properties. The general form of this product is disposable plastic bottles in drinking water. Waste plastic bottles are usually used for disposables product. Referring to this condition, they can assume and increase over a certain period the number of waste plastic bottles, where as plastic bottles are the largest source of pollutants on earth. To control this condition, it is necessary to develop a sustainable mechanism of press machine for flattening the waste plastic bottle into sheet plastic before being crushed and recycled into other products. Based on the observation of test results, it was found that the design of press machine for waste plastic bottle works with electric motor well, before being reprocessed.

Keywords: sustainable, waste plastic bottle, beverage packaging, pressing machine, electric motor

1. Introduction

The use of disposable plastic bottle is generally only used for single-use products, that is why the use of plastic waste bottle having negative impact when refilling again [4]. Related research is also widely explained in various articles that the use of plastic bottle in drinking water bottle contains bisphenol A (better known as BPA), a chemical which is used in the plastic industry [10]. These dangerous chemicals can cause the water inside having dangerous bacteria growth when the bottle is opened because of serious health consequences. Moreover, the use of disposable plastic bottle is usually made from PET or PET (polyethylene terephthalate), which is safe to use but it is not intended to be reused. This plastic can dissolve dangerous chemicals only when be heated or scratched [3]. Although they are clearly labelled as disposable product, some people still reuse PET bottles repeatedly for cost-saving reasons or more practical when refilling [13]. In generally, if people consider and understand about the health impact factors, commonly they throw out. Consideration and feasibility as a reason why they are hazardous to health when reused [14]. The accumulation of waste plastic bottles will be abundant if they are not properly controlled, disrupting the sustainability of ecosystems in nature. Nowadays, the amount of waste plastic bottle



in the world has reached 300 million tons per year [7]. According to BBC News, the amount of waste plastic bottle will be around ten times on earth [4]. Moving away from this problem, more than sixty countries have taken practical measures to limit the use of plastic waste on earth including Indonesia policy [11]. More recently, according to a second report, dozens of turtles have died off the coast of Bangladesh after being captured by waste plastic. The animals were released back into the Bay of Bengal, but some returned to the coastline, which stretches for 120 km [6]. About 30 turtles have died and are buried in the sand. Many turtles are injured from being entangled in 50 tons of waste plastic when floating, it is about 10 km along the coast. The turtles do not only end up in the trash, but also eat up waste plastic and causing many of these animals will die. Not only, turtles see these floating in the sea like jellyfish to eat, but also they see waste plastic as animal from its smell. The smell or scent coming from submerged or floating plastic is a "deceiving scent" for turtles, based on an explanation of Dr Joseph P from University of Florida, Gainesville [6]. Plastics where have been at sea for a long time and have a scent to attracts sea turtles, and this is an evolutionary adaptation in the search for food. However, this is now a problem for sea turtles because they are attracted to the smell of plastic. Not only animals, but also plastic enters the human body in the form of micro plastics through food, drinks, and even when the air breathed [9]. But in addition to the large of its negative impact, plastic has the positive side as being reported by the European Plastics Industry Association. It is also said that at the end of its cycle, plastic waste still remains to become a very valuable resource because it can be converted to new raw materials or converted to energy, because due to the presence of waste plastic, which increases its capacity and as a result, there is less land left, it is necessary to innovate to try to reduce and recycle waste plastic [12]. Based on the problems and conditions of existence, the waste plastic gives an idea to create a tool that can reduce the volume of waste plastic, especially waste plastic bottle, which will then be used by the plastic bottle crusher at the continued stage of research. This press machine is specially designed for flattening the sheet of waste plastic bottle before processing into plastic flakes [13]. Press machine for waste plastic bottle can temporarily help to minimize the use of existing land for disposing of waste plastic and others waste plastic bottle, and can be useful for easy recycling and creating into plastic accessories according to the needs of its users [10].

2. Methodology

2.1 Type of press machine

Press machine is generally widely used for processing activities in the manufacturing industry [1]. Some of press machine applications are always used in the manufacturing industry for blanking, piercing, bending, riveting, embossing, and others [18]. Monitoring of many applications of press machine and the existing background of accumulation of waste plastic bottle, the function of the press machine is used for the processing of reduced volume of waste plastic bottle with flat-shaped sizes [8]. Press machine generally has a variety of methods for transferred energy, i.e mechanical, hydraulic and pneumatic. Where as mechanical press machine generally use flywheels so that require a more complex transmission system. Hydraulic press machine is more widely used for large loads but the speed of movement is relatively slow. Hydraulic press machine also need a set of supporting equipment such as pumps, storage tanks and pipes with large dimensions to withstand large pressures. Meanwhile, many pneumatic press machines are recommended because the construction is simpler than the others. A simple press machine consists of valves, cylinders, and compressors and easy to move.

2.1.1 Hydraulic press machine

This machine is generally used to process various types of raw material presses such as waste plastic, used cans, cardboard boxes, paper, and various other products. Generally, this type of

press machine is widely used to compact objects so they do not require a large storage area before being sent to the recycling process. Hydraulic press machine has generally strong and sturdy construction, and easy to operate, the shape and size of the press product results can also be adjusted to the needs of users [2].

2.1.2 Pneumatic press machine

Press machine develop rapidly in the manufacturing sector as well as in the home industry. Generally, the construction of pneumatic press machine is simple with a more secure level for operator safety. Besides that, the transferred energy system uses air with flexible construction. Pneumatic systems are used in controlling train doors, automatic production lines, mechanical clamps, etc [18].

2.1.3 Mechanical press machine

There are several types of mechanical press machines. One of the following types is commonly used in the industrial sector. Screw press is a press machine whose driving mechanism in the worm gear construction that moves the worm gear as part of the engine slide. This type of machine is less effective for mass production. Another type is the rack press is a mechanical press machine in which the driving mechanism is a gear (pinion) that moves part of the slide that integrates with the rack. This type of machine is less effective for mass production needs, too [17].

2.2 Selected type of press machine

To sustain for the design mechanism in this study is to select a mechanical press machine which using electric motor drive of gear system. The reason for selecting the driving force is to analysis the quality of the results and quick response of the average of flatting process with press machine with gear transmission and electric motor against the mechanism with others engine driving forces [19].

2.3 Electric motor

Electric motor is a tool to convert electric energy into mechanical energy. Besides that, tools that function in reverse, converting mechanical energy into electric energy are called generators or dynamos. Electric motors can be found in household appliances such as fans, washing machines, water pumps and vacuum cleaners. Electric motors that are commonly used in the industrial world are asynchronous electric motors, with two global standards namely IEC and NEMA (**Figure 1**). Metric (millimeter) asynchronous IEC motors, while imperial-based NEMA electric motors (inches), in the application there are power units in the horsepower (HP) or kilowatt (KW). Loads can generally be categorized into three groups [16]:

- Constant torque load is a load where the demand for output energy varies with the speed of operation but the torque does not vary. In this research, the design of a waste plastic packaging press machine commonly uses this method. The reason is because of the working principle with a constant machine. Other constant torque load applications i.e. conveyors, rotary kilns, and constant displacement pumps.
- Loads with variable torque, where loads with torque that vary with operating speed. Load applications with variable torque, i.e. centrifugal pumps and fans (torque varies as the square of the speed).
- A load with constant energy is a load with torque demand that changes inversely proportional to speed. Applications for constant energy loads are commonly for machine tools.



Figure 1. Electric motor for disposable plastic bottle press machine

2.4 Limit switch

Figure 2 shows that this switch can be used as a pilot device for the magnetic starter control circuit, which allows it to start, stop, slow down, or speed up the function of the electric motor. The limit switch can be mounted to the machine as a control instrument for standard operation or as an emergency device to prevent damage to the engine. Most switches are maintained contacts or instant contact models.

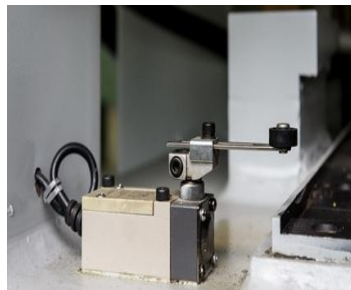


Figure 2. Limit switch as a contact is used to detect objects as machine control

2.5 Gear transmission

The gears are used to transmit large power and precise shifts. The gears have gears around them, so the forwarding of power is carried out by the gears of the wheels which interlocked with each other. The gears are often used because they can spin and more power for diverse and more compact using other transmission tools. In **Figure 3**, transmission gear system is used to transmit power for pressing.



Figure 3. Transmission gear system

2.6 Parts and its configuration

In the design, mechanism of the press machine use anvil and pressing part so that waste plastic bottle can be properly pressed during the flaking process. **Figure 4** and **Figure 5** show the construction of anvil and pressing mechanism of waste plastic bottle.



Figure 4. Anvil and pressing mechanism for waste plastic bottle



Figure 5. Pressing part operation and bushing for pressing

2.7 Assembly

Press machine assembly consists of a combination of parts, e.g. bushing, frame, anvil and pressing parts, electric motors with gear transmission (**Figure 6**).



Figure 6. Assembly of press machine for waste plastic bottle

2.7.1 Equipment and material

Material for testing use waste plastic bottle in drinking water, where the lid of the bottle has been removed and arranged in a box and then pressed by using a rotated pressure shaft with an electric motor (**Figure 7**). At the time of pressing condition, the bottles are arranged horizontally with different amounts to study the force's response of waste plastic bottle. In order, calculations are not discussed in the current design but also by experiment results. The thickness of the pressing pad is made with a fixed thickness of 3 mm [8]. Measuring instruments used for measuring of waste plastic bottle, which listed below:

- Vernier calipers
- Ruler
- Ballpoint
- Worksheets data



Figure 7. Test results of disposable plastic waste bottle machine

Flowchart design and prototyping of disposable plastic waste bottles press machine which is used for test can be seen in **Figure 8**.

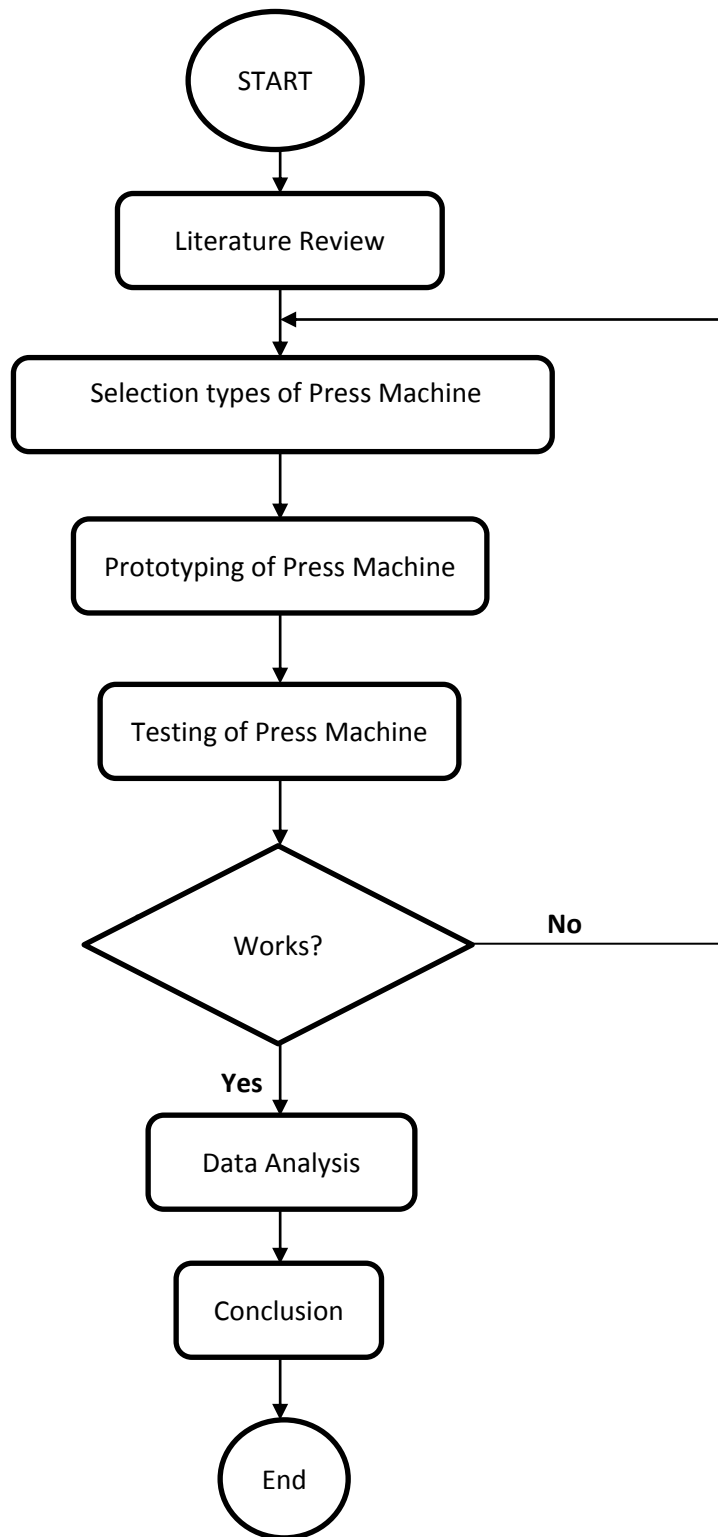


Figure 8. Design Methodology for mechanical press machine

3. Results and discussion

This research paper gives the optimum design of mechanical press for pressing operations using electric motor. The main function of mechanical press is to press thin sheet waste plastic bottle using electrical power. We successfully make the design of mechanical press for pressing operations. Our design has met its objective to produce the waste plastic bottle in the sheet. Mechanical presses are available in many types of construction which is also true of mechanical presses. Following construction details just gives the basic idea of dimensions of different parts used in the design module. Anvil is installed at the bottom of the movable plate. The basic testing process is shown in below at figure 9 where as calculation of our design is safe. From the test results with 5 tests, the average of each test result is obtained statistically using a press machine that was designed and manufactured to obtain the following test results. Averaged validity of the experimental results for the arrangement line of disposable plastic bottles with the optimal level of confidence must be in the data deviation that can be seen as follows and in Table 1 and Figure 9.

- $t_1 = 35.2 \pm 0.64$ mm
- $t_2 = 33.8 \pm 1.04$ mm
- $t_3 = 33.2 \pm 1.36$ mm

Table 1. Test results of press machine

Arrangement	Experiment (mm)				
	I	II	III	IV	V
First line (t_1)	36	35	36	34	35
Second line (t_2)	36	34	32	34	33
Third line (t_3)	35	34	34	33	30

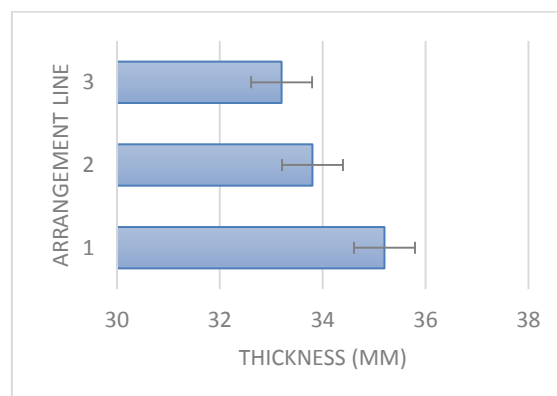


Figure 9. Arrangement line vs thickness sheet of waste plastic bottle

4. Conclusion

To get the quality of pressing waste plastic bottle when processing must have:

- Composition of waste plastic bottles should be arranged in a horizontal position with increasing number of lines in order to obtain small scale plastic sheet results.
- The optimal range of loading varies from average, and the measurement tolerance can be analyzed by the position of each line.
- The press machine works well when pressing the waste plastic bottle.
- Optimum average validity of waste plastic bottle after pressing is about 33.2 ± 1.36 mm at third line.

- Press machine for waste plastic bottle can temporarily help to minimize the use of existing land for disposing of waste plastic and others waste plastic bottle before recycling.

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