

# Paper 77\_Sustainability Design of Press Machine

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# Sustainability Design of Press Machine for Used Plastic Bottle with Electric Motor

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**Abstract.** Plastic waste can be a pollutant that can damage the environment. If this waste is not well controlled, it will certainly harm the sustainability of other ecosystems. Usually, plastic waste is difficult to decompose naturally, and even if it decomposes, it will take a long time, from 100 to 500 years. The main source of plastic waste is usually the use of plastic material itself, which is used as an acid product or to support the use of everyday life that is inseparable. In general, the use of plastic materials, because it has several considerations, includes 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 plastic bottles for beverage packaging. These plastic bottles for beverage bottles are usually used for disposables. Referring to this condition, we can assume that over a certain period the number of plastic waste bottles for beverage packaging has increased, where plastic bottles for beverage packaging are the largest source of pollutants in nature. To control this condition, it is necessary to develop a sustainable press mechanism for flat processing plastic bottles and beverage packaging bottles before being crushed and recycled for processing into other products. Based on the test results, it was found that the press machine design for plastic beverage packaging can do the level of process long before being reprocessed using an electric motor.

**Keywords:** sustainable, waste, packaging, press machine

## 1. Introduction

The use of plastic beverage bottles is generally only used for single-use products. This is because the use of plastic bottles can negatively impact those who reuse it by refilling them. The research related to this is also widely explained in various articles that say that the use of plastic bottles in drinking water bottles contains bi phenol A (better known as BPA), a chemical used in the plastics industry. These dangerous chemicals can cause the water inside them to grow into more dangerous bacteria when the bottle is opened and have very serious health consequences. In addition, the use of disposable plastic beverage bottles is usually made from PET or PET (polyethylene terephthalate) plastic, which is safe to use but not intended to be reused. This plastic can dissolve chemicals in drinking water when heated or scratched. Although they are clearly labelled as disposable, there are quite a few people who reuse these PET bottles repeatedly for cost-saving reasons or more practical when refilling. But if you consider and understand the health impacts in general, the owners of plastic beverage bottles are usually thrown away because they are hazardous to health if reused. The accumulation of waste from plastic beverage bottles will be abundant if not properly controlled,

disrupting the sustainability of ecosystems in nature. The amount of plastic waste in the world today has reached 300 million tons per year. To quote the BBC (8/8/2019), this amount of plastic waste when compacted will be 10 times around the Earth. Moving away from this problem, more than 60 countries have taken practical measures to limit the use of plastic waste. Some are doing a complete ban, some at the expense of excise taxes, as Indonesia did. More recently, according to a second report, dozens of turtles or turtles have died off the coast of Bangladesh after being captured by plastic waste. The animals were released back into the Bay of Bengal, but some returned to the coastline, which stretches for 120 km (75 miles). About 30 turtles have died and are buried in the sand. Many turtles are injured from being entangled in 50 tons of waste floating 10 km along the coast. The turtle not only ends up in the trash, but it also eats up plastic waste, causing many of these animals to die, according to the BBC. Turtles not only see plastic waste floating in the sea like jellyfish to eat, the researchers said, but they also see animal-like smell of plastic. The smell or scent coming from submerged or floating plastic is a "deceiving scent" for turtles, based on an explanation from Dr Joseph P from University of Florida, Gainesville. "Plastics that have been at sea for a long time have a scent that 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 these animals, plastic also enters the human body in the form of micro plastics through food, drinks, and even the air we breathe. But in addition to the large negative impact that the positive side of plastic waste still has, as 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 plastic waste, which increases its capacity and as a result, there is less land left, it is necessary to innovate to try to reduce and recycle plastic waste. Based on the problems and conditions of existence, does the plastic bottles for beverage packaging give an idea to create a tool that can reduce the volume of plastic waste, especially plastic bottles, namely waste packaging machine for beverage packaging plastic bottles, which will then be used by the waste plastic beverage bottle crusher at the next stage of research. This plastic bottle machine is specially designed to flatten bottled plastic beverage packaging before processing it into plastic flakes. This bottle for plastic beverage packaging machine can temporarily help minimize the use of existing land for disposing of plastic beverage packaging waste and other plastic waste, and can be useful for easy recycling into other plastic beverage packaging bottle products, creating other plastic accessories according to the needs of its users.

#### 1.1.Press Machine Types

Press machines are generally widely used for processing activities in the manufacturing industry. Some of the applications of these presses in the manufacturing industry include: blanking, piercing, bending, riveting, embossing, etc. Seeing the many applications of press machines and based on the existing background, which is related to the accumulation of waste packaging plastic bottles, the function of the press machine used here is used for the process of reducing the volume of waste plastic bottles of beverage packaging into plastic bottles with flat-shaped sizes. Press machines generally have a variety of methods, including mechanical, hydraulic and pneumatic. Mechanical press machines generally use fly wheels so that they require a more complex transmission system. Hydraulic press machines are more widely used for large loads but the speed of movement is relatively slow. Hydraulic press machines 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, because only with valves, cylinders, and compressors that are easily moved.

#### 1.1.1. Hydraulic Press Machine

This machine is generally used to process various types of raw material presses such as plastic waste, used cans, cardboard boxes, paper, and various other products. Generally, this type of press machine is widely used to compact these objects so they do not require a large storage area before being sent to the recycling process. Hydraulic press machines are generally strong and sturdy construction, easy to operate, the shape and size of the product press results can also be adjusted to the needs of users.

#### 1.1.2. Pneumatic Press Machine

This press machine developed rapidly in the manufacturing sector as well as in the home industry. Generally, the construction of this pneumatic press machine is simple with a more secure level of security and operator safety. Besides, that the energy transfer system uses air and is very flexible.

#### 1.1.3. Mechanical Press Machine

There are several types of mechanical press machines, the following are commonly used in the industrial sector, namely screw press is a press machine whose driving mechanism is the worm gear 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.

#### 1.2. Selecting the Design Press Type

Sustain for the design mechanism in this study was selected a mechanical press machine using electric motor drive using a gear system. The reason for selecting the driving force is to analysis and compare the quality of the results of the thin process average of bottled beverage packaging by using press machine with gear transmission electric motor against the mechanism with other engine driving forces.

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#### 1.3. Electric motor

Electric motor is a tool to convert electrical energy into mechanical energy. Tools that function in reverse, converting mechanical energy into electrical 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. 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).



**Figure 1.** Electric motor draft press machine for plastic beverage packaging

Loads can generally be categorized into three groups (BEE India, 2004):

- 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 bottled beverage waste plastic packaging press using this method, because the working principle is a constant machine. Other constant torque load applications are: conveyors, rotary kilns, and constant displacement pumps.
- Loads with variable torque are loads with torque that vary with operating speed. Load applications with variable torque, are: 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 and is inversely proportional to speed. Applications for constant energy loads are machine tools.

#### 1.4. 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 are interlocked with each other. The gears are often used because they can spin and power more diverse and more compact using other transmission tools. According to the location of the shaft, the direction of rotation and shape of the gear line, the conversion gear into three namely:

##### 1.4.1. Aligned Gear Shaft.

This gear has teeth that are aligned in two cylindrical planes (distance to the circle), the two planes are tangent and one is rolling on the other with the axis still aligned.

- Spur gears  
A spur gear is the most basic gear with a gear line that is parallel to the shaft. The easiest construction, but produces axial forces. Suitable to choose for large circumferential styles. Spur gears have noisy properties at high speed.
- Bevel gears  
Bevel gears have a gear path that forms a thread at a distance for the circumference. In tilted gears, the number of pairs of gears makes contact with each other larger than straight gears, so that the rotation of the rotation can run smoothly, very suitable for transmitting high rotation and large loads. The tilted gear is inserted in a stronger gear, because the screw-mounted gear lane creates a reaction force parallel to the shaft.
- Double helical gear  
Double helical gear teeth have a tooth path that forms threads at a certain distance for a wider circumference than straight teeth. This gear can move a reduction ratio, circular speed and great strength, but makes it rather difficult.
- Internal gear  
internal gear is used if a small size transmission device is desired, with a large reduction ratio because the pinion is located inside the gear. Good for transmitting rotations with large reductions
- Rack and pinion gear  
Rack and pinion gear are used to convert rotational movements into straight movements or vice versa straight movements into rotary movements.

##### 1.4.2. Gears With Intersecting Axes

The basic form is two cones with joint peaks that are tangent to each other down a straight line.

- Straight bevel gears.

Straight bevel gears with straight teeth are the most widely made and most frequently used but are very noisy due to their small contact ratio. Construction does not allow mounting of bearings on both ends of the axles.

- Spiral bevel gear  
Spiral bevel gears have a greater contact ratio than straight cone gears, so they can continue high rotation and large loads. The bevel gear shaft angle of the spiral is usually made  $90^\circ$ .
- Surface gears  
The surface gear is suitable for moving large power, but it is noisy at high rotations because of its small contact ratio.

#### 1.4.3. Crossed Axle Gears

The basic form is two cylinders or cones whose axes are crossed with each other.

- Crossed bevel gear  
Crossed bevel gears have a large contact area ratio so that they are suitable for transmitting high rotation.
- Cylindrical worm gear  
Cylindrical worm gears can continue rotation with a large but noisy reduction ratio at high rotations.
- Globoid worm gear  
Globoid worm gears can continue rotation with a large reduction ratio and are able to transmit greater power when compared with cylindrical worm gears because globoid worm gears have a greater contact ratio.
- Hypoid gears  
Hypoid gears have a spiral-shaped tooth lane on the cone plane whose axes are crossed and the transfer of power to the tooth surface takes place in a sliding and rolling manner



**Figure 2.** Transmission gear system

#### 1.5. Limit Switch

Limit switches consist of operational control actuators, housing switch mechanisms, and a series of electrical terminals used to connect switches to the controlled electrical circuits. Operational controls that work are part of the limit switch that is in contact with the target. The actuator contains, connected to a working head, linear, perpendicular or rotating motion which is then translated by the actuator to close or open the switch. The switch housing contains a switch contact



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mechanism, the condition of which is controlled by the drive. Electrical terminals are connected to switch contacts and allow cables to be connected to switches through terminal screws. Industrial equipment that undergoes automatic operation usually requires switch control which is activated according to the movements involved in the operation of the machine. To be reused, the accuracy of the electrical switch must be reliable and the response speed must be fast. Due to the mechanical characteristics and performance of various machines, factors such as size, labor, mounting methods and travel speed are important characteristics when installing and maintaining limit switches. In addition, the electrical power from the limit switch must be in accordance with the load of the mechanical system, which it will control to avoid operating the device. In most cases, the limit switch starts operating when the moving machine or moving parts of the machine make contact with the actuator or the operating lever that activates the switch. The limit switch then regulates the electrical circuit that controls the engine and moving parts. 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 3.** Limit switch as a contact is used to detect objects as machine control

#### 1.6.Component Parts

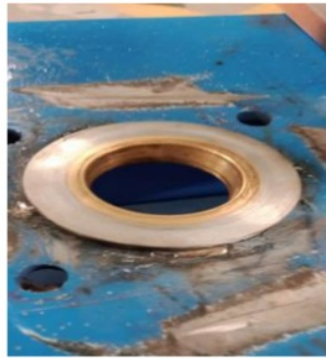
In the design of the press machine mechanism using anvil and pressing tools so that the bottled beverage waste can be properly pressed during the flaking process. The following is the construction of anvil and its pressing tool mechanism.



**Figure 4.** Anvil and pressing mechanism in the design of beverage plastic bottle waste machines



**Figure 5.** Pressing tool on the design of beverage plastic bottle waste machines



**Figure 6.** Bushing on the design of the beverage plastic bottle waste machine

#### 1.7.Assembly

Press machine that is designed is a combination of component parts consisting of parts, such as: bushing, frame, anvil and pressing tools, electric motors and gear transmission.



**Figure 7.** Assembly design of plastic beverage packaging bottles waste machines

Press machines that have been assembled are followed by a series of tests. The following preparations are made:



#### 1.7.1. Equipment and Materials

The material to be used is a used plastic drink packaging bottle, where the lid has been removed such as where the bottle will be arranged in a box and pressed using a pressure shaft that is rotated by an electric motor. At the time of pressing, the bottles are arranged horizontally with different amounts to study the force's response to thick thickness. Order calculations are not discussed in the current design. The thickness of the pressing pad is made with a fixed thickness of 3 mm. Measuring instruments used in the measurement of thick used plastic bottles include:

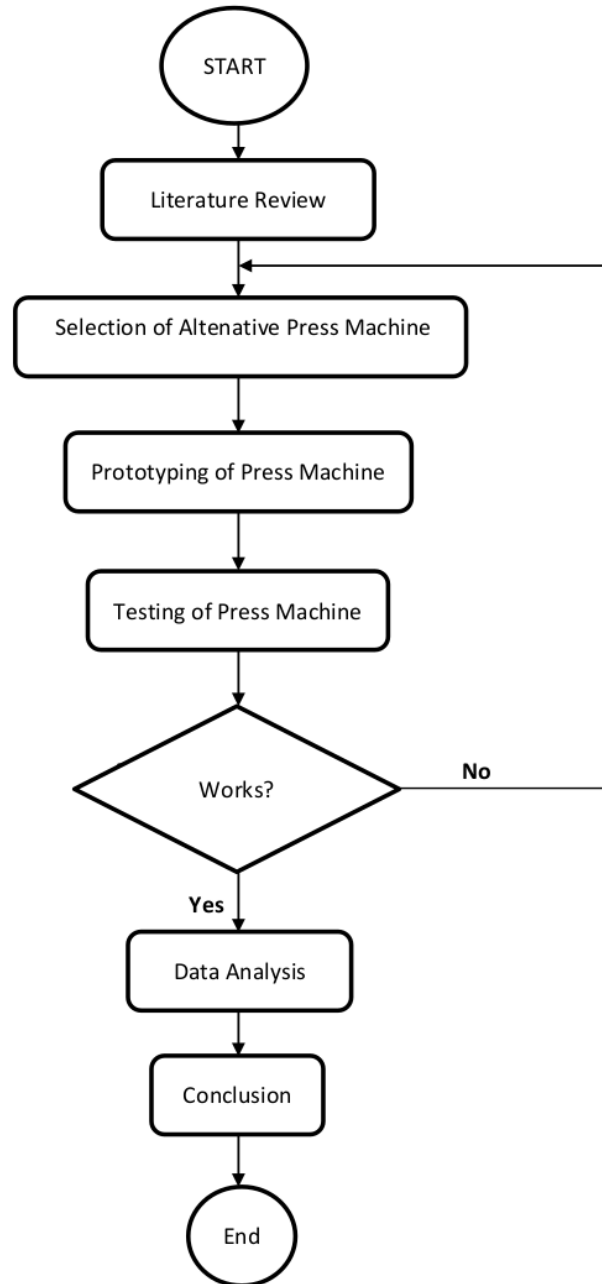
- Vernier calipers
- Ruler
- Ballpoint
- Worksheet data



**Figure 8.** The results of pressing the bottled beverage waste

## 2. Methodology

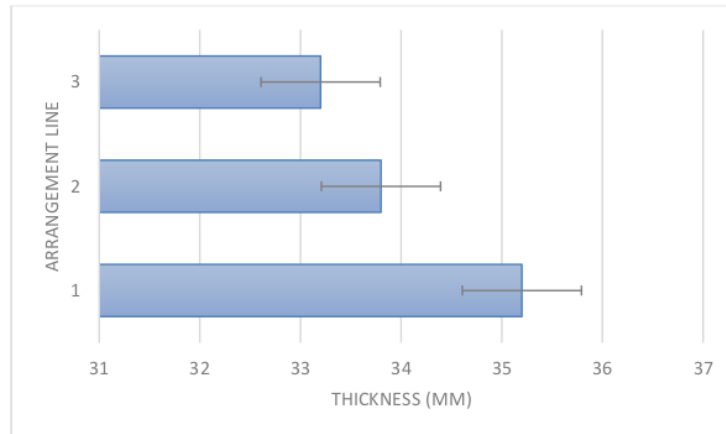
The following is the press machine design flow of plastic bottles for beverage packaging



**Figure 9.** Methodology for designing press machine for beverage bottled waste

### 3. Results and discussion

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:



**Figure 10.** Effect of arrangement line of plastic bottle waste after levelling

The results of the experimental worksheets carried out using this press machine can be made as follows

**Table 1.** Press test results

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

The average validity of the experimental results for the arrangement of the packaging bottles with the optimal level of confidence must be in the data deviation that can be seen as follows:

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

### 4. Conclusion

To get the quality of thick flattening with this press, then:

- Composition of plastic beverage bottles should be arranged in a horizontal position with increasing number of lines in order to obtain thinner press results.
- The optimal range of bottle loading thickness varies from average, and the measurement tolerance can be analyzed by the position of each row.
- The press works well for leveling.

### 5. Acknowledgement

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