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Design and Fabricate a Thermoforming Tool Used for Making Leaf Cups

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ABSTRACTp

The goal of this project is to develop and build a thermoforming tool for manufacturing leaf cups. The forming tool is made of mild steel with an aluminium coating. Because of its simple design, it is quite portable. This machine can make leaf cups out of any variety of (semi-dried leaves). Plastics can be avoided if necessary (eco-friendly). The machine's main goal is to stay away from plastics. Another goal of the project is to provide people the opportunity to start their own SSI and eventually become entrepreneurs. The machine's punch and die can be simply replaced. Punches and dies of various sizes can be added depending on the need. The heating coil's temperature can be modified depending on the size of the raw material. A single takes between 40 and 50 seconds to create. Increase the temperature in the heating coil to shorten the time.

Keywords: thermoforming; fabrication and leaf cups

1. Introduction

The thermoforming market is often divided into thin-gauge and thick-gauge segments. Disposable items, such as rigid packaging, are popular in thin-gauge industries. Permanent or industrial items are popular in thick-gauge markets. Thin-gauge sheets are those with a starting thickness of less than 1.5 mm. It is commonly extruded in the form of rolls that are 1 to 1.5 metres in diameter. The rolls can weigh up to 1800 kg and contain up to 3000 metres of sheet. Roll-fed thermoformers are used to feed the sheet constantly into thermoformers. Thick-gauge sheets are those that have a thickness of more than 3 mm at the start. It is often extruded and chopped or guillotined into distinct pieces, which are then stacked on pallets. These pieces are subsequently put into cut-sheet thermoformers, which are either manually or automatically fed. Sheets with a thickness between 1.5 and 3 mm are frequently too expensive for disposable products and too thin for structural purposes. However, this mid-gauge sheet is finding a rising market in under-the-hood automobile applications and large-volume, deep-draw drink containers.Thermoformed packaging is less dimensionally accurate than injected moulded packaging, and less intricate designs (e.g., undercuts) are possible, but it is often faster and less expensive to make. The thermoforming technique involves heating a sheet of uniform thickness (which can be mono, coextrusion, or laminate) and pulling it over or into a mould to generate a hard or semi-rigid shape. The surplus material is usually trimmed away, leaving a rim around the finished product. One of the most important downsides of this apparently easy technique is that the material will thin, even to the point of breaking, as the depth of the object to be created increases.Extrusion of sheets was discussed earlier in the chapter. If necessary, the sheet can be foamed (using EPS expanded polystyrene, cellular polypropylene, or polyethylene). If polypropylene is being cast, it is common practise to extrude the sheet in the same direction as the thermoforming. The most popular thermoforming sheet is coextruded multilayer sheet, which has the required performance and barrier properties. Many packaging vendors produce the sheet and thermoform it into the desired pack shape, whilst some packer-fillers thermoform trays from a pre-supplied reel of sheet material, insert the product in it, and heat seal a flexible lid onto the tray all on the same machine.After the sheet has been heated, the container can be constructed in a variety of ways. Traditionally, the heated sheet was draped over a cavity or plug mould, a vacuum was drawn, and the sheet was formed to the shape of the mould. This approach is appropriate for simple shallow thermoformed packing components. Plug assist vacuum forming is the preferred option if the depth is higher than the diameter. The sheet is produced, the wall thins, and there is a possibility that the sheet will not conform well to the shape of the mould, especially at the bottom margins, in traditional vacuum thermoforming. Plug assist

addresses some of these shortcomings by acting as a heat sink and displacing material in a more equal manner, minimising wall thinning. This is especially beneficial for elements that are deeply drawn. The sheet billows upwards due to heat and/or pressure, a hot plug is supplied, and the vacuum is turned on, creating the sheet over the mould.Many plastics emit vinyl chloride and other hazardous gases, or contain phthalates, which can cause cancer, birth defects, lung and liver disease, and other problems. Some plastics, such as those found in our televisions, laptops, cell phones, coffeemakers, water bottles, and food containers, are right out in the open. However, certain plastics are found in unexpected areas. Wherever you least expect them, sanitary napkins, chewing gum, cosmetics, mattresses, and carpeting. Tissues, toilet paper, and upholstery are all made of polyester.The formation of fungus on the surface of the raw material is caused by an increase in moisture content, which degrades the raw material's and end product's quality. Temperature control of the die-punch during operation appears to be critical. Moisture content and temperature are also noted to vary from machine to machine. Finally, it is noted that the regulation of these characteristics is critical for producing a high-quality product. This research will also aid in the development of a high-performance equipment for the production of areca nut leaf plates. The process of heating a thermoplastic sheet to its softening point is known as thermoforming. The sheet is stretched and controlled across a single-sided mould. Then it cools to its final shape.

2. Literature Survey

High temperatures and pressures are used to construct the three-dimensional (3D) cup shape utilising flexible polyurethane foams. Nonetheless, the design of the mould head and the control of the bra cup moulding process are extremely difficult and error-prone **[1].** Metal retort cans, glass bottles, paperboard cartons, and even corrugated containers are being replaced by plastic packaging. It creates a barrier, keeping food safe for longer, reduces packaging weight, gives convenience and transparency where needed, and consumes less than 4% of oil resources **[2].** When compared to other compression moulded natural fibre composites such as other kenaf, sisal, and coir reinforced thermoplastics, the kenaf–PP composites compression moulded in this study had greater tensile and flexural strength **[3].** Plastics' success stems from nearly a century of successful polymer research and technological development. Despite extensive study over the last 20 years, polymer-based nanocomposites (PNC) are newbies to the food packaging market **[4].** For prototype thermoforming moulds, the recycled fibreglass filler dough has the potential to be an ideal alternative. Each of the ten parts made from each mould had nearly little variance. Thirteen of the fifteen moulds produced parts with a standard variation of less than 0.003 inch **[5].** Before forming, the sheets sagged to varied degrees. The thickness and surface strain distribution of the produced component are affected by sagging **[6].** Injection moulding, extrusion, thermoforming, and compression moulding are examples of common technologies. Based on patents and literature reviews, a manufacturing technique for green composites via compression moulding and thermoforming is created in this chapter **[7].** For example, increasing the usage of recycled materials by 25% reduces environmental impacts by 35–56%, demonstrating improved performance in terms of global warming and fossil depletion impacts **[8].** High impact polystyrene (HIPS) sheets were thermoformed into axisymmetric cups using a plug-assist technique in which the aluminium plug temperature (Tplug) was adjusted from ambient to above the glass transition temperature of HIPS (100 °C) in the current work **[9].** The goal of this project is to develop and build a prototype machine that can produce 3D printing filaments from recycled Polyethylene Terephthalate Polymers (PET/PETE), which is commonly used in water bottles **[10].**

3. Methodology

Aluminium may be processed using almost any method (machining, welding, forming, extrusion), and it is usually easier to work with than other metals. The machine's base plate is mild steel with a self-weight of 10 kg to withstand the load. The lever is actuated by two pillars soldered into the sides of the base plate. The slot in the lever allows you to modify the punch height. To endure the high temperature, the punch and die are manufactured of mid steel. Between the plywood board and the die

is the aluminium coil. The wood is there to protect you from electric shock. Because leaf liquid can damage it, it is coated with aluminium to make it corrosion resistant.

During rural feasts, the leaves are frequently employed in the shape of affordable organic leaf plates and cups. They have numerous advantages, particularly when cooked alongside the dish. They're high in natural fibre, and their astringent properties make them great for the skin. It is biodegradable and environmentally friendly. Cups of any size can be manufactured. Leaves are often used for betta conditioning and care, and they are thought to help in a variety of ways, including increasing ferity, health, and vitality. Reduce the pH of the water to aid in the recuperation of diseased or damaged animals, and the tannin will quickly colour the water.The lever has a slot for aligning the punch and die. To hold the punch, a U-clamp is attached in the slot of the lever. A wooden grip is placed at the end of the lever, which serves as a handle. For automatic die opening, the lever is attached to the spring. During rural feasts, the leaves are frequently employed in the shape of affordable organic leaf plates and cups. They have numerous advantages, particularly when cooked alongside the dish. They're high in natural fibre, and their astringent properties make them great for the skin. It is biodegradable and environmentally friendly. Cups of any size can be manufactured.Leaf cups are an excellent alternative to plastic/polymer-based products, as well as paper-based products, about which the entire world is concerned. These plates are made entirely of natural materials. Almond leaf that has fallen from the trees is gathered, cleaned, and soaked in water for around 15 minutes before being shade dried for 30 minutes. They are subsequently compacted into various shapes with the appropriate shaped equipment.Compostable, biodegradable, and environmentally friendly. No trees are cut down; instead, fallen leaves are gathered and converted into a valuable product, a waste-to-wealth notion. No bleaching of the pre-coating wax coating using chemicals at any time. Non-crushable and light weight. Micro trash and fridge safe. Hold the liquid stem without leaking for 4 hours. Suitable for both hot and cold items. Flood plates tossed after editing will disintegrate naturally in 60 days, just like any other plant matter. Almond sheath manufacturing waste will be used for vermin compost and dry folder for animal biofuel.The milling machine is a versatile machine tool, meaning it can be utilised for a wide range of tasks. It can do a range of tasks that would normally be performed by other machine tools. It is used not only for machining flat and irregularly shaped surfaces, but also for drilling, boring, reaming, slotting, and cam milling gears and threads. The work item is fed against a rusty multipoint cutter in a milling machine for machining. The cutter spins at a rapid rate. Because the cutter has several cutting blades, it can quickly remove metal.

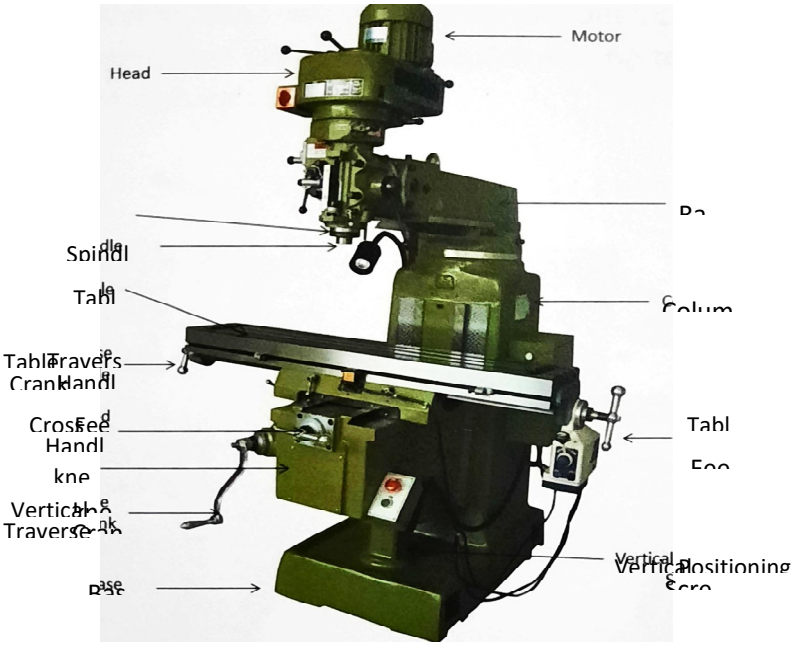


Fig 1 shows the milling machine

Grinding is a method of eliminating metal. A grinding wheel revolving at high speed removes the metal in this operation. Grinding is typically employed as a finishing step. Grinding procedures are used to finish the majority of the goods. This is because grinding generates a high-quality surface polish and precision. Grinding can easily machine and polish very hard surfaces.

Fig 2 shows surface grinding

The main function of a lathe is to machine cylindrical shapes. The contour is created by rotating the work in relation to a single-point cutting tool. The cutter is moved parallel to the axis of rotation to machine the exterior surface. Alternatively, metal can be removed from the inside of the work, in which case the activity is referred to as boring. Facing occurs when a tool is moved across the work's surface.Spring steel refers to a variety of steels that are used to make springs, most notably in automotive and industrial suspension applications. Lowalloy manganese steels, medium-carbon steels, and high-carbon steels with a high yield strength are the most common. This enables spring steel items to revert to their original shape after substantial deflection or twisting. Many grades of steel can be hardened and tempered to make them suitable for use as springs; however, some steels have more desired spring qualities.Because aluminium has a low melting point, it can be easily melted and reused in its entirety. Aluminium is the material of choice for numerous areas and applications, including automotive, aerospace, construction, energy, marine, food processing, and many more. Aluminium has three times the thermal conductivity of steel due to its light weight, making it an excellent heat exchanger. It can also conduct twice as much electricity as copper of the same weight. When aluminium comes into touch with the atmosphere, it automatically shields itself by producing an oxide layer on its surface that prevents further corrosion.This layer is stable in the pH range of 4-9 and regenerates spontaneously when damaged, extending the life of aluminium. Strength: While aluminium has a low tensile strength by itself, it may readily be alloyed with other materials such as Silicon or Copper (among others) to improve this feature. It also enhances strength while maintaining toughness in cold weather, which steel does not accomplish. The punch and die are made of mild steel with an aluminium coating. Heat is easily absorbed by aluminium. The punch and die are simple to replace. It's used for a variety of component sizes. Cups of various sizes can be produced. Because of the heating coil, the shape is easily created.

4. Results and Discussion

In Indian villages, leaf cups and plates are typically created by hand. They're frequently used to serve meals in religious and social gatherings. The time-consuming craft may now be converted into elephant-shaped and sized containers using a machine. Apart from being affordable, hygienic, and bio-degradable, such cups and plates offer good structural stability. Plant leaves are cleaned, dipped in water, and dried. The leaf is placed on the bottom die pattern, which is pressed down and released after a few seconds. The folding, trimming, and shaping are completed in one action by pressing the pedal on the machine.

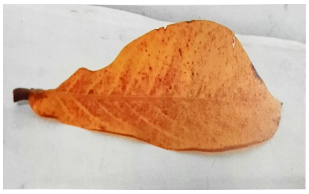
Raw material	Component
	
	
	

Fig 3 shows leaf material

The huge size of almond leaves is why they were chosen. Due to the restriction on plastics, these leaf cups can be used in place of plastic cups. Plastics are not necessary. These mugs can be composted. It is simple to obtain raw materials. The machine is inexpensive. Plastics are not necessary. The cost of raw materials is nothing.

Table1 material costing

SI.NO	DESCRIPTION	AMOUNT IN RS
1	MILD STEEL	3000
2	ALUMINUM	800
	Total	3800/-

This method is used to estimate the project's cost before it is put into production.

Table 2 machining cost

Sl NO	DESCRIPTION	AMOUNT IN RS
1	Lathe	3200

2	Aluminum coating	1000
	Total	8,000/-

Aluminium is a corrosion-resistant metal that produces a protective layer called aluminium oxide. This layer protects the metal's surface from corrosion. Surface treatment, such as painting or anodizing, can also help to increase metal's overall corrosion resistance. Pure aluminium is a soft, ductile metal that resists corrosion and has a high electrical conductivity. Although it is commonly used for foil and conductor cable, it must be alloyed with other elements to offer the higher strength required for other applications. Aluminium is a soft and pliable silvery-white lightweight metal. Aluminum is utilised in a wide range of products, including cans, foils, kitchen and window frames, beer kegs, and aircraft components. This is due to its unique characteristics. Aluminium is the third most plentiful element after oxygen and silicon, and the most abundant metal in the crust, while it is less common in the mantle below. It makes up roughly 8% of the Earth's crust. Bauxite is the most common resource of aluminium. Because aluminium is so chemically reactive, natural specimens are uncommon and only found in intense reducing conditions. Instead, it can be found in over 270 distinct minerals in combination. Aluminium is notable for its low density and the phenomena of passivation, which allows it to resist corrosion. Aluminium and its alloys are essential in the aircraft industry, as well as transportation and the construction industries, where they are used in building facades and window frames. The most useful aluminium compounds are oxides and sulphates.

Table 3 material movement

Operations materials	**Milling**	**lathe**	**drilling**	**Grinding**	**VMC**
Base plate	Yes	No	yes	Yes	No
Forming die	No	Yes	Yes	Yes	Yes
Forming punch	No	Yes	Yes	No	Yes
U-clamp	Yes	No	Yes	Yes	No
Lever	Yes	No	Yes	Yes	No

Areca nut leaf plates, also known as areca leaf plates, are biodegradable plates made from areca leaves. Areca leaf bowls and plates are made by collecting the best specimens of areca leaves that cover areca fruits and using them to make these products. Areca leaf plates and goods have been utilised as biodegradable and environmentally friendly eating options for a long time.The beautiful thing about utilising areca leaf plates, bowls, and dining utensils is that they are made without chemicals, which means they are completely safe for all users. These products are made using a detailed and complete production procedure. These goods are made from the fallen husk leaves of areca nut plants. After gathering the falling husks, they are pressure cleaned and sun-dried. The raw material is then shaped and sterilised in this manner. The naturally shed husks are remarkable in that they are robust and semi-flexible without being fragile. The husks are also fully odourless and heat and water resistant.There are no dangerous ingredients in the plates and other products manufactured from areca leaves. The tableware will compost organically in about two months and will decay

naturally in two to three months. Birthday parties, everyday eating, restaurants, and kitchenware may all benefit from tableware manufactured from top quality areca leaves. It can also be used as kitchenware and for heating food in the microwave. Furthermore, the strong and light structure of these plates makes them ideal for both buffet events and packing.

Areca leaf bowls and plates are now available from a reputable online retailer. Areca leaf plates may be purchased online, which not only allows you to obtain these products from the comfort of your own home, but also allows you to obtain the greatest pricing. It may also provide you with the option of selecting from a variety of products. As a result, buying areca leaf items online is recommended because it makes it easier to obtain products that are truly cutting-edge.

5. Conclusion

Because of its small size, the machine is easily transportable. In the same machine, different size punches and dies can be substituted. The machine is also quite inexpensive. Both men and women can operate with ease. The machine provides better security. For simple cutting, cutting edges can be added at the punch. Punches and dies of various sizes can be utilised. By modifying the shape of the punch die, several cup shapes can be made.

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