DEVELOPMENT OF CORN HUSK CUP MAKING MACHINE

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Introduction:

Corn (Zea mays), a globally significant cereal crop, plays a crucial role in India's agricultural economy, with production expected to reach 37 million metric tons in 2024-25. Despite its importance, maize processing generates vast amounts of corn husks, which are often discarded or burned, causing environmental pollution. Meanwhile, the extensive use of plastic and paper cups has led to ecological concerns, including non-biodegradability, deforestation, and carbon emissions. To address these challenges, this project proposes the development of a Corn Husk Cup Making Machine, which utilizes pneumatic and thermal processing technologies to mold corn husks into biodegradable cups. This innovation offers a sustainable alternative to plastic and chemically processed paper cups while promoting waste management and green manufacturing. The project aligns with circular economy principles, reducing reliance on non-renewable materials and minimizing environmental impact. Additionally, it fosters economic empowerment by creating new revenue streams for rural communities through the utilization of agricultural waste. The machine's scalability makes it suitable for widespread adoption, particularly in maize-producing regions like Karnataka, where high productivity rates enhance feasibility. By transforming waste into eco-friendly products, this project provides a cost-effective and impactful solution to global pollution and deforestation concerns.

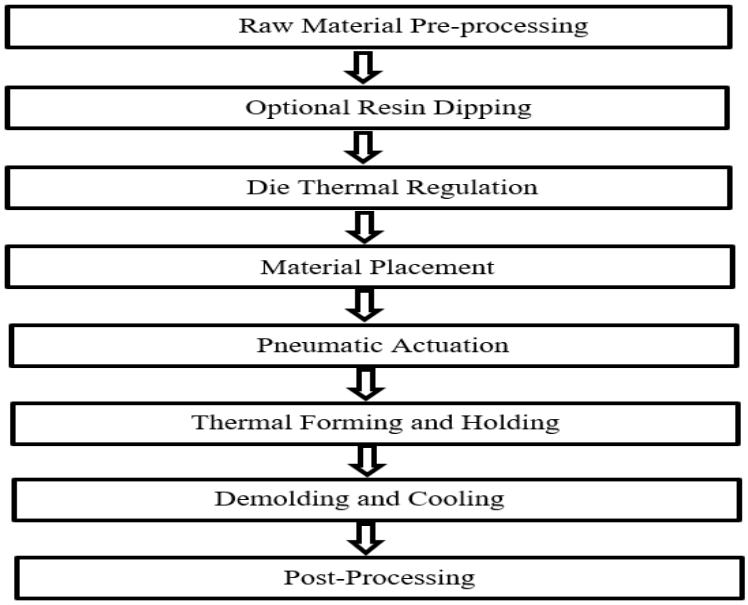
Objectives:

- To Develop of corn husk Bowl making machine.
- To evaluate the performance of corn husk Bowl making machine.
- To study the cost economics of corn husk bowl making machine.

Methodology:

Methods, Techniques, and Materials Used

The project focuses on transforming corn husk waste into biodegradable cups using structured processing and fabrication methods. The entire process is designed to be environmentally friendly and cost-effective.



The raw material preprocessing method includes cleaning, drying corn husks. Cleaning is done using air or water to remove dirt and dust. Drying is performed under sunlight to reduce moisture content.

An optional resin coating method is used for waterproofing and enhancing the mechanical strength of the cups. In this step, husks are dipped into a biodegradable resin, such as (Sugarcane juice, castor oil), and allowed to drain before moving to the molding phase. (if needed)

Die heating is employed to heat the aluminum or stainless-steel dies to a specific range of 70°C–85°C. The temperature is regulated using resistance heating coils and a dimmer circuit to ensure consistency and prevent fibre degradation.

Material placement involves positioning the pre-treated husk centrally on the lower die to ensure uniform pressure during compression. Proper alignment minimizes waste and improves cup quality.

Pneumatic actuation is the technique used for forming the cups. A pneumatic cylinder powered by compressed air applies uniform pressure to press the husk into the die cavity.

The thermal forming and holding method keeps the husk under heat and pressure for 30–40 seconds. This ensures the husk conforms to the mold and gains structural integrity.

After molding, demolding and cooling is performed. The upper die retracts, and the cup is cooled using open air to prevent deformation.

In the post-processing stage, rough edges are manually trimmed, and final drying is done to eliminate any residual moisture, increasing the product's shelf life.

The techniques used in this project include air cleaning, resin dipping, resistance heating, temperature control via dimmer circuit, pneumatic pressing, manual trimming.

The materials used include corn husks as the primary raw material and biodegradable resin for optional coating. Structural components include C-channel frame tubes, GI square steel tubes, MS flat plates, and plain sheets. Forming parts consist of Stainless-steel dies, pneumatic cylinders, DCVs, pneumatic pipes, and bushes. Electrical elements like heating coils, dimmer circuits, wiring, and other electronic components regulate temperature and control. Assembly is completed using various fittings and fasteners for strength and stability.

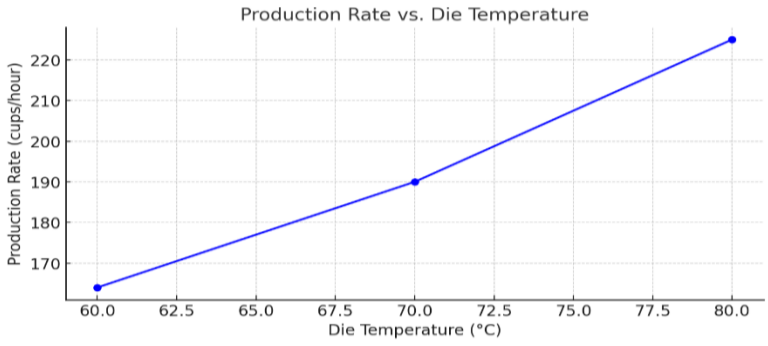
Result and Conclusion:

Analysis of Production Parameters

The graphs presented provide insights into how independent parameters such as die temperature, pneumatic pressure, and cycle time influence the production rate of the corn husk cup-making machine. These findings help optimize the machine's performance and efficiency.

1. Production Rate vs. Die Temperature

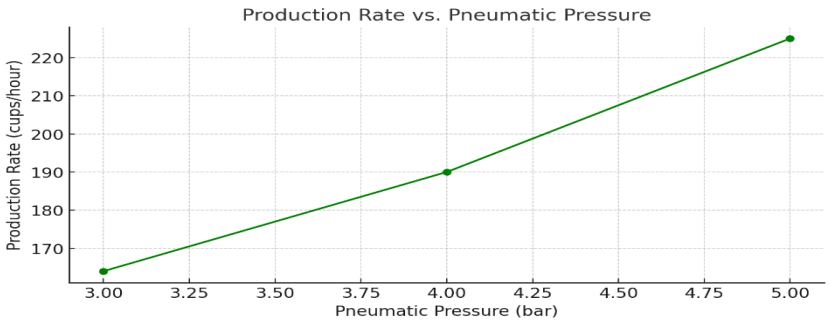
The cycle time is reduced, leading to an increase in production rate, At 80°C, the production rate reaches its maximum of 225 cups/hour, compared to 164 cups/hour at 60°C.



Graph 1. Production rate v/s Die Temperature

2. Production Rate vs. Pneumatic Pressure

Higher pneumatic pressure ensures a more effective molding process by applying sufficient force to shape the cups quickly., At 5 bar, the production rate reaches 225 cups/hour, while at 3 bar, it remains at 164 cups/hour.



Graph 1.2 Production rate v/s Pneumatic pressure

Machine Performance: The machine molds corn husks into biodegradable cups in 25 seconds per cup under optimal conditions (80°C, 3 bar pressure), achieving a production rate of 114 cups per hour. Quality assessments show uniform shape, structural integrity, and durability suitable for practical use.

Material Utilization: Each cup uses 4 husks, costing ₹0.20 per unit. Treated husks offer improved strength and water resistance, ensuring reliable performance.

Cost Efficiency: The production cost per cup is ₹0.59, with a selling price of ₹1.00, resulting in a profit margin of ₹0.41 per cup, making the process economically viable.

Efficiency: The machine operates with 90.27% efficiency, producing 90 defect-free cups out of every 100, demonstrating strong operational performance.

In conclusion, the Corn Husk Cup Making Machine offers a sustainable, eco-friendly solution to replace plastic and paper cups. Utilizing agricultural waste like corn husks, it transforms them into biodegradable cups using pneumatic and thermal systems. The machine operates efficiently with heated dies (70–85°C) and forms cups within 30–40 seconds. With a low fabrication cost of ₹25,550, it supports small-scale industries and promotes rural entrepreneurship.

Project Outcome & Industry Relevance:

The Corn Waste Cover Bowl Making Machine converts corn husk waste into biodegradable bowls, promoting sustainability and reducing plastic pollution. It supports waste management, circular economy, and eco-friendly product development. This technology benefits rural entrepreneurs, small industries, and food packaging sectors. It can be scaled for mass production, creating jobs and reducing environmental impact.

Working Model vs. Simulation/Study: This project involves the development of a physical working model rather than a theoretical study or simulation. The machine has been designed, fabricated, and tested to ensure it efficiently processes corn husk into usable bowl-shaped products. The prototype demonstrates the feasibility of converting

agricultural waste into value-added products. Performance parameters such as durability, production efficiency, and environmental benefits have been analyzed through experimental trials.

Project Outcomes and Learnings:

- Successfully designed and fabricated a prototype for making bowls from corn husk.
- Demonstrated a sustainable and cost-effective method for agricultural waste utilization.
- Evaluated the mechanical and structural properties of the bowls to ensure practical usability.
- Explored potential market applications for biodegradable products.

Learnings from the Project:

- Understanding the mechanical and thermal processing of corn husk fibers.
- Challenges in achieving optimum mold shape, compression, and drying techniques.
- Importance of sustainable product design and material selection.
- Real-world testing, performance analysis, and scalability considerations for industry adoption.

Future Scope

- Blending corn husk with other agricultural residues like rice husk or wheat straw could improve strength and aesthetics.
- Automation of DCV operation can reduce manual intervention and increase production consistency.
- Using alternative food-safe resins can ensure safer and longer-lasting biodegradable cups.
- Enlarging the die size can enable the production of bigger cups and containers, meeting broader market needs.
- Adding an in-built cutting system will allow precise trimming, improving cup uniformity and finish.

- Incorporating sensors and timers could allow smart monitoring of temperature and forming time.
- Future designs can focus on user-friendly controls and digital interfaces for ease of use and precision.