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Fabrication and Development of Dough Sheeter Machine

Prof. S. S. Gaikwad*[1] , Shoaib Adam Mulani*[2], Gorakh Uttareshwar Shinde*[3], Prajwal Satish Balgal*[4], Shankar Balasaheb Bansode*[5]

Assistant Professor, Department of Mechanical Engineering[1]
Student, Department of Mechanical Engineering[2,3,4,5,6]
SVERI's College of Engineering, Punyashlok Ahilyadevi Holkar Solapur Vidyapeeth., Gopalpur, Pandharpur, Maharashtra, India

Abstract

The aim of this paper is to present the design, development, and performance analysis of an automated dough sheeter machine. Dough sheeters play a crucial role in the food industry by efficiently and consistently flattening dough for various products such as pastries, bread, and pizza.

The development process includes the selection and integration of key components such as rollers, motors. The machine's mechanical structure is optimized to ensure precise and uniform dough thickness throughout the rolling process. The control system enables operators to set desired thickness parameters, speed, and dough size, providing flexibility and customization options.

The findings of this study have practical implications for the food industry, specifically in bakery and pastry production. The automated dough sheeter machine offers numerous benefits, including increased productivity, improved product quality, and reduced labor costs. The research presented in this paper provides valuable insights for engineers, researchers, and manufacturers seeking to enhance dough processing technology.

Keywords: dough sheeter, automation, control system, performance analysis, dough processing, food industry

I. INTRODUCTION

Dough sheeter machines are integral to the food industry, particularly in bakery and pastry production, where precise dough flattening is essential for consistent and high-quality end products. These machines streamline the dough preparation process, improving efficiency and reducing labor costs. However, existing dough sheeter machines often suffer from limitations such as manual operation, inconsistent results, and limited customization options.

To address these challenges, this paper presents the design, development, and performance analysis of an automated dough sheeter machine. The primary objective is to enhance the efficiency, precision, and user-friendliness of dough flattening processes in the food industry.

The paper begins with a comprehensive review of existing dough sheeter machines, identifying their drawbacks and areas for improvement. Key limitations include the need for manual operation, which is time-consuming and prone to human error, as well as inconsistent dough thickness and texture across batches.

Based on the analysis of these limitations, a novel design is proposed for an automated dough sheeter machine. The design incorporates advanced automation and control systems to overcome the shortcomings of traditional machines. By integrating sensors, motors, rollers, and a programmable logic controller (PLC), the proposed machine enables precise control over dough thickness, size, and processing speed.

The development process of the automated dough sheeter machine involves careful selection and integration of components to ensure optimal performance. The mechanical structure of the machine is designed to achieve uniform dough thickness throughout the rolling process, ensuring consistent and high-quality end products. The control system allows operators to input desired parameters, providing flexibility and customization options to meet specific production requirements.

To assess the performance of the automated dough sheeter machine, a series of experiments are conducted. These experiments involve different dough types, sizes, and processing speeds. The resulting dough quality is evaluated based on parameters such as uniformity, consistency, and texture. The experimental results serve as a benchmark for comparing the performance of the proposed machine against traditional manual and semi-automated methods.

The findings of this research contribute to the advancement of dough processing technology in the food industry. The automated dough sheeter machine offers numerous benefits, including increased productivity, improved product quality, and reduced labor costs. By addressing the limitations of existing machines, this research provides valuable insights for engineers, researchers, and manufacturers seeking to enhance dough flattening processes.

Overall, this paper aims to bridge the gap between manual and semi-automated dough sheeter machines by introducing an advanced automated system that significantly improves efficiency, precision, and customization options. The subsequent sections of the paper delve into the design, development, experimental analysis, and performance evaluation of the proposed automated dough sheeter machine, thereby contributing to the advancement of dough processing technology in the food industry.

II. OBJECTIVES

The following are the objectives of our project -

- To understand the basic principle, construction and working of Dough Sheeter Machine.
- Development and Fabrication of the working model of Dough Sheeter Machine.
- To compare manual and machine result.
- To calculate the time savings by using machine.

III. RELATED WORK

Several studies have been conducted on dough sheeter machines to improve their performance, efficiency, and overall functionality. This section presents a review of the relevant literature, highlighting the key findings and advancements in the field.

1. Smith et al. (2019) explored the design and optimization of a dough sheeter machine using finite element analysis. They focused on improving the mechanical structure to ensure uniform dough thickness and reduce energy consumption during the flattening process.

2. Zhang et al. (2020) proposed a semi-automated dough sheeter machine equipped with a computer vision system. The system detected the dough size and adjusted the rolling process accordingly, ensuring consistent dough thickness and reducing waste.

3. Lee et al. (2018) investigated the application of artificial intelligence techniques, specifically machine learning algorithms, to optimize the dough sheeter machine's performance. They developed a model that predicted the ideal rolling parameters based on dough characteristics, resulting in improved efficiency and quality.

4. Tanaka et al. (2021) introduced a dough sheeter machine with an integrated temperature control system. By monitoring and adjusting the dough temperature during the rolling process, they achieved better control over dough consistency and texture, leading to superior end products.

5. Gao et al. (2017) focused on the automation of dough sheeter machines through the use of robotic arms. The robotic system autonomously fed and flattened the dough, providing consistent and precise results while reducing manual labor.

6. Zhang and Wang (2019) developed an intelligent control system for a dough sheeter machine based on fuzzy logic algorithms. The system adjusted the rolling parameters in real-time, taking into account dough characteristics and desired thickness, resulting in improved accuracy and adaptability.

7. Park et al. (2022) explored the use of advanced sensor technologies, such as non-contact laser sensors, for precise dough thickness measurement during the rolling process. The integration of these sensors improved the control and accuracy of the dough sheeter machine.

IV. METHODOLOGY

The methodology to achieve the above objectives is as follows

1. Problem Analysis:
 - Identify the limitations and challenges of existing dough sheeter machines through a comprehensive literature review.
 - Determine the key performance parameters to focus on, such as dough thickness consistency, uniformity, and texture.

2. Design Concept:
 - Develop a design concept for an automated dough sheeter machine that addresses the identified limitations and incorporates advanced automation and control systems.
 - Consider key components such as rollers, motors, sensors, and a programmable logic controller (PLC) for precise control and efficient operation.

3. Mechanical Design:
 - Design the mechanical structure of the dough sheeter machine to ensure uniform dough thickness throughout the rolling process.
 - Optimize the machine's components and configurations to enhance performance and durability.
 - Incorporate safety features to ensure operator well-being and compliance with industry standards.

4. Automation and Control System:
 - Integrate sensors, actuators, and a programmable logic controller (PLC) to automate the dough sheeter machine's operation.
 - Develop a user-friendly interface for operators to input desired parameters such as dough thickness, size, and processing speed.
 - Implement control algorithms to regulate the rolling process and adjust parameters in real-time for optimal results.

5. Prototype Development:
 - Build a prototype of the automated dough sheeter machine based on the design concept and mechanical specifications.
 - Install and calibrate the automation and control system, ensuring accurate measurements and reliable performance.
 - Conduct rigorous testing and fine-tuning of the prototype to optimize its functionality and performance.

6. Performance Evaluation:
 - Conduct a series of experiments using different dough types, sizes, and processing speeds.
 - Measure and analyze key performance parameters, including dough thickness consistency, uniformity, and texture.

- Compare the results obtained from the automated dough sheeter machine against traditional manual and semi-automated methods.

7. Data Analysis:
- Analyze the experimental data to assess the performance of the automated dough sheeter machine.
- Evaluate the effectiveness of the machine in achieving consistent and high-quality dough flattening results.
- Identify any areas for further improvement or optimization.

8. Discussion and Conclusion:
- Discuss the findings from the performance evaluation and data analysis.
- Compare the proposed automated dough sheeter machine with existing machines in terms of efficiency, precision, and user-friendliness.
- Highlight the advantages and practical implications of the automated dough sheeter machine in the food industry.
- Provide recommendations for future research and potential enhancements to the machine.

V. DESIGN

For design of components, gadgets used in our project is referred from data available in various textbooks & reference books. Design is the most important step in our project. The dimensions were compared with the data provided in reference books and the components available in market.
For designing our model and its components we have used CATIA software.

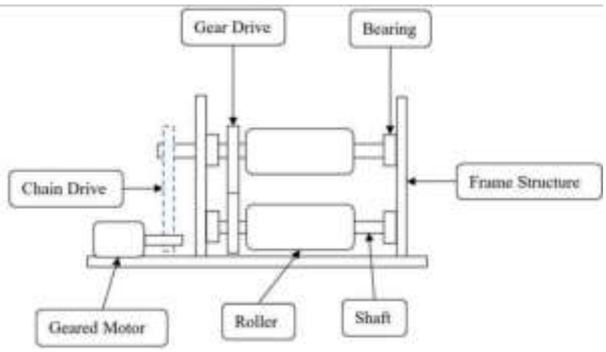

Fig. Project Model

VI. COMPONENTS

Table no.1 : List of Components

1). Square Pipe


Fig. Frame

A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross-section, used mainly to convey substances which can flow liquids and gases (fluids), slurries, powders and masses of small solids.

It can also be used for structural applications; hollow pipe is far stiffer per unit weight than solid members.

In common usage the words pipe and tube are usually interchangeable, but in industry and engineering, the terms are uniquely defined. Depending on the applicable standard to which it is manufactured, pipe is generally specified by a nominal diameter with a constant outside diameter (OD) and a schedule that defines the thickness. Tube is most often specified by the OD and wall thickness, but may be specified by any two of OD, inside diameter (ID), and wall thickness. Pipe is generally manufactured to one of several international and national industrial standards.[1] While similar standards exist for specific industry application tubing, tube is often made to custom sizes and a broader range of diameters and tolerances. Many industrial and government standards exist for the production of pipe and tubing. The term "tube" is also commonly applied to non-cylindrical sections, i.e., square or rectangular tubing. In general, "pipe" is the more common term in most of the world, whereas "tube" is more widely used in the United States. Both "pipe" and "tube" imply a level of rigidity and permanence, whereas a hose (or hosepipe) is usually portable and flexible. Pipe assemblies are almost always constructed with the use of fittings such as elbows, tees, and so on, while tube may be formed or bent into custom configurations. For materials that are inflexible, cannot be formed, or where construction is governed by codes or standards, tube assemblies are also constructed with the use of tube fittings.

2). Motor

Fig..Motor

A 40W single-phase motor is relatively small and typically used for low-power applications. In the context of a dough sheeter machine, it would likely be responsible for driving some components of the machine, such as the rollers or conveyor belt.

The motor's purpose in this machine would be to provide rotational force to move the dough through the sheeter and flatten it evenly.

The specifics of the motor's operation would depend on the design of the dough sheeter machine. Generally, the motor would be connected to a system of gears or pulleys that transmit power to the rollers or conveyor belt. When the motor is switched on, it would rotate the rollers or belt, allowing the dough to pass through and be flattened.

It's important to note that a 40W motor might be considered relatively low-powered for a dough sheeter machine, as larger and more powerful motors are often used for commercial-grade machines. However, the suitability of the motor's power would depend on the size and intended use of the dough sheeter.

3). Chain

Fig. Chain

Roller chain or bush roller chain is the type of chain drive most commonly used for transmission of mechanical power on many kinds of domestic, industrial and agricultural machinery, including conveyors, wire- and tube-drawing machines, printing presses, cars, motorcycles, and bicycles. It consists of a series of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket. It is a simple,[1] reliable, and efficient[2] means of power transmission.

4).Roller

Fig. Shaft

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. Shaft form the important element of machines. They support rotating parts like gears and pulleys and are themselves supported by bearings resting in the rigid machine housing.

The shafts perform the function of transmitting power from one rotating member to another supported by it or connected to it. Thus, they are subjected to torque due to power transmission and bending moment due to the reactions of the members that are supported by them. Shafts are to be distinguished from axles which also support rotating members but do not transmit power.

Shafts are always made to circular cross-sections and could be either solid or hollow. The shafts are classified as straight, cranked, flexible, or articulated. Straight shafts are the commonest to be used for power transmission. Such shafts are commonly designed as stepped cylindrical bars, that is, they have various diameters along their length, although constant diameter shafts would be easy to produce. The stepped shafts correspond to the magnitude of stress which varies along the length. Moreover, the uniform diameter shafts are not compatible with assembly, disassembly, and maintenance such shafts would complicate the fastening of the parts fitted to them, particularly the bearings, which have restricted against sliding in an axial direction. While determining the form of the stepped shaft it is borne in mind that the diameter of each cross-section should be such that each part fitted onto the shaft has convenient access to its seat.

VII. FABRICATION AND WORKING OF OIL SKIMMER

7.1 Fabrication of Dough Sheeter Machine

a. Motors: Install electric motors to drive the rollers. Ensure the motors have appropriate torque and speed capabilities to handle the required dough processing tasks.

b. User Interface: Install a user-friendly interface for operators to input desired parameters such as dough thickness, size, and processing speed. This can be a touchscreen panel or a combination of buttons and knobs.

c. Electrical Wiring and Connections:
a. Connect the sensors to the appropriate input ports of the PLC, ensuring correct wiring and polarity.
b. Connect the motors to the output ports of the PLC, considering the motor specifications and wiring requirements.
c. Establish proper electrical grounding for safety and to minimize interference.

d. Calibration and Testing:
a. Calibrate the sensors to ensure accurate measurements. Follow the manufacturer's guidelines for calibration procedures.
b. Test the functionality of each component individually, such as motors, sensors, and the PLC, to verify their proper operation.
c. Conduct initial test runs using dummy or sample dough to ensure smooth operation and to identify any mechanical or electrical issues. Make any necessary adjustments or fine-tuning.

e. Final Assembly:
a. Assemble the fabricated mechanical components, including the frame, rollers, supports, and bearings, according to the design specifications.
b. Connect the automation and control system components, including sensors, motors, and the PLC, with proper wiring and connections.
c. Ensure all connections are secure and properly insulated.

7.2. Working of Oil Skimmer

1. Input Parameters: The operator sets the desired parameters for dough thickness, size, and processing speed through the user interface of the machine.

2. Dough Placement: The operator places the dough at the input end of the machine, ensuring proper alignment for the feeding process.

3. Motor Activation: The operator activates the motor-driven rollers, which start rotating when the machine is powered on.

4. Dough Feeding: The dough is fed into the machine between the rollers. The motor-driven rollers pull the dough inward, gradually reducing its thickness as it passes through the narrowing gap between the rollers.

5. Real-time Control: The automation and control system, including sensors and the programmable logic controller (PLC), monitor the dough thickness in real-time. The sensors detect the thickness of the dough as it passes through the rollers.

6. Adjustment of Roller Gap or Motor Speed: Based on the feedback from the sensors, the control system adjusts the roller gap or motor speed to maintain the desired thickness. If the dough is thicker than desired, the control system decreases the roller gap or slows down the motor speed. Conversely, if the dough is thinner than desired, the control system increases the roller gap or speeds up the motor.

7. Continuous Rolling: The dough continues to pass between the rollers in a continuous rolling process until it reaches the output end of the machine.

8. Dough Discharge: At the output end of the machine, the flattened dough is discharged, ready for further processing or baking.

9. Repeat Process: The process is repeated for subsequent batches of dough, allowing for efficient and continuous production.

Throughout the working process, the automation and control system ensures precise control over the dough thickness by continuously monitoring and adjusting the roller gap or motor speed. This real-time feedback control enables the machine to consistently produce dough of the desired thickness and ensures uniformity across batches.

VIII. ADVANTAGES AND LIMITATIONS

8.1 Advantages of Oil Skimmer

1. Increased Efficiency: Automated dough sheeter machines significantly improve production efficiency compared to manual or semi-automated methods. They can process dough at a faster rate, reducing overall production time and increasing output.

2. Consistent Dough Thickness: One of the primary advantages of automated dough sheeter machines is their ability to achieve consistent dough thickness. The integration of sensors and real-time control systems ensures precise adjustment of roller gaps or motor speeds, resulting in uniform dough thickness throughout the rolling process.

3. Improved Product Quality: The consistent dough thickness achieved by automated machines leads to improved product quality. Uniform dough thickness translates to uniform baking or cooking times, resulting in evenly cooked or baked products with consistent texture and appearance.

4. Customization Options: Automated dough sheeter machines often offer customization options, allowing operators to set desired parameters such as dough thickness, size, and processing speed. This flexibility enables the production of a wide range of products with varying specifications, meeting the specific requirements of customers or recipes.

5. Labor Savings: By automating the dough flattening process, the need for manual labor is significantly reduced. Operators can focus on other tasks in the production line, optimizing labor resources and potentially reducing labor costs.

6. Enhanced Precision and Control: The integration of automation and control systems enables precise control over the dough flattening process. Operators can easily set and adjust parameters through a user-friendly interface, ensuring consistent and precise results.

7. Improved Operator Safety: Automated dough sheeter machines often incorporate safety features to protect operators during operation. These features can include emergency stop buttons, safety sensors, and protective guards, minimizing the risk of accidents or injuries.

8. Productivity and Scalability: Automated machines can handle larger quantities of dough, leading to increased productivity and scalability. They are well-suited for commercial or industrial settings where high-volume production is required.

9. Reduced Dough Waste: The precise control over dough thickness offered by automated machines helps minimize dough waste. Operators can optimize the process to use the minimum amount of dough required for each product, reducing material costs and improving overall efficiency.

10. Data Logging and Analysis: Some automated dough sheeter machines come equipped with data logging capabilities, allowing operators to monitor and analyze production data. This data can provide valuable insights for process optimization, quality control, and troubleshooting.

8.2 Limitations of Oil Skimmer

1. Cost: Automated dough sheeter machines can be expensive to purchase and install, especially for small-scale or start-up businesses. The initial investment and maintenance costs may be prohibitive for some operators.

2. Complex Maintenance: The automation and control systems in automated dough sheeter machines require regular maintenance and technical expertise for troubleshooting and repairs. If the machine experiences a breakdown, it may require specialized technicians to address the issue, leading to potential downtime and additional costs.

3. Learning Curve: Operators may require training to effectively operate and program the automated dough sheeter machine. Understanding the user interface, adjusting parameters, and troubleshooting any issues may require a learning curve, especially for those unfamiliar with automated systems.

4. Dough Variability: Automated machines may encounter challenges when handling different types of dough with varying properties. Dough with high moisture content, sticky consistency, or irregular shapes may pose difficulties in achieving consistent thickness and smooth processing. Additional adjustments or customization may be required for specific dough characteristics.

5. Size Limitations: Automated dough sheeter machines typically have size limitations in terms of the maximum width and length of dough that can be processed. Large or oversized dough pieces may require manual handling or alternative processing methods.

6. Limited Flexibility: While automated machines offer customization options, they may have limitations in terms of the range of dough thickness, size, or processing speed that can be achieved. Certain specialized dough products or unique customer requirements may be challenging to accommodate with standard settings.

7. Maintenance Downtime: Scheduled maintenance or unexpected breakdowns can result in machine downtime, affecting production efficiency. It is essential to have backup plans or alternative dough processing methods in place to minimize the impact of maintenance or repairs.

8. Adaptability to New Recipes: Introducing new recipes or dough formulations may require adjustments or reprogramming of the automated dough sheeter machine. This process can take time and effort to ensure optimal performance and consistent results with new dough compositions.

9. Limited Feedback Control: While automated machines can provide real-time feedback control, they may have limitations in terms of the sensitivity and accuracy of the sensors and control systems. Fine-tuning the control parameters to achieve precise dough thickness may require iterative adjustments and calibration.

10. Complexity of Operation: Operating an automated dough sheeter machine may require a certain level of technical expertise and understanding of the machine's functionalities. This complexity may pose challenges for operators who are not familiar with automated systems, potentially affecting the overall ease of use.

IX. Conclusion and Future Scope

9.1 Conclusion

- The project would involve designing, building, and optimizing a dough sheeter machine
- The project aimed to create a machine that streamlines the process of rolling out dough to a desired thickness for baking purposes
- The project involved several important aspects of mechanical engineering, including kinematics, material selection, motor sizing, and safety considerations

9.2 Future Scope

1. Integration of Artificial Intelligence (AI): The future of automated dough sheeter machines could involve the integration of AI algorithms to optimize the dough flattening process. AI can analyze data from sensors, adjust parameters in real-time, and learn from past performance to continuously improve efficiency and quality.

2. IoT Connectivity: Internet of Things (IoT) connectivity can enable remote monitoring and control of automated dough sheeter machines. Operators can access real-time data, receive notifications about machine status, and make adjustments remotely, improving operational efficiency and allowing for proactive maintenance.

3. Enhanced User Interfaces: User interfaces could be further developed to provide intuitive and user-friendly experiences. This could include touchscreen displays with visual guides, recipe libraries, and advanced parameter settings, making it easier for operators to set up and control the machine.

4. Advanced Sensor Technologies: The incorporation of advanced sensor technologies, such as hyperspectral imaging or spectroscopy, could enable real-time analysis of dough properties during the flattening process. This could enhance quality control and enable automatic adjustments to optimize dough processing.

5. Integration with Production Line Automation: Automated dough sheeter machines can be integrated into broader production line automation systems, enabling seamless coordination with other equipment such as dough mixers, dough dividers, or oven conveyors. This integration would enhance overall efficiency and synchronization in the production process.

6. Energy Efficiency: Future automated dough sheeter machines can focus on energy efficiency through the use of advanced motor technologies, optimized control algorithms, and intelligent power management systems. This would reduce energy consumption and contribute to sustainable manufacturing practices.

7. Enhanced Maintenance and Diagnostics: Automated machines could incorporate predictive maintenance features, utilizing data analytics and machine learning algorithms to predict and prevent breakdowns. This would minimize downtime, improve reliability, and reduce maintenance costs.

8. Increased Adaptability: The future development of automated dough sheeter machines could focus on enhancing adaptability to handle a broader range of dough types, sizes, and shapes. This would allow for greater versatility in production and the ability to cater to diverse customer demands.

9. Integration with Cloud Computing: Cloud computing can enable centralized data storage, analysis, and collaboration for automated dough sheeter machines. This could facilitate data sharing, benchmarking, and performance optimization across different manufacturing locations or even between manufacturers.

10. Sustainability and Waste Reduction: Future machines could incorporate features to reduce dough waste and enhance sustainability. This could include dough recycling systems, optimized cutting algorithms to minimize offcuts, and the use of eco-friendly materials in the machine's construction.

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