International Journal on Advanced Computer Theory and Engineering

ISSN: 2319 - 2526

Volume 15 Issue 2s (2026) | Pages: 327-332

Design and Development of a Rubber Component Deflashing Machine for Small Scale Production

Akshay B. Saundane[1], Tanveer H. Shaikh[2], Ram N. Dasade[3], Prathamesh S. Gorane[4], Vijay B. Raundal[5]

[1,2,3] Student in Mechanical Engineering Department at G.S. Moze College of Engineering

[4,5] Assistant Professor in Mechanical Engineering Department at G.S. Moze College of Engineering

Peer Review Information

Type: *Article*
Received:*23 February 2026*
Revised: *24 March 2026*
Accepted: *22 April 2026*
Published: *20 May 2026*

Abstract

The rubber molding industry frequently encounters the challenge of removing excess material, known as flash, from molded components. Manual deflashing methods are labor-intensive, time-consuming, and often result in inconsistent product quality, particularly for small-scale manufacturing units with limited resources. This research presents the design and development of a cost-effective, semi-automatic pneumatic deflashing machine specifically engineered for small-scale rubber component production.
The proposed machine integrates a robust metal frame structure, a pneumatic cylinder for controlled actuation, a push-button valve for operator control, and a custom-designed cutting die tailored to specific rubber component geometries. The methodology encompassed comprehensive mechanical design, pneumatic system integration, and rigorous performance testing against traditional manual deflashing techniques.
Experimental results demonstrate that the developed machine achieves significant reductions in cycle time, improves deflashing consistency, and enhances overall product quality while maintaining operational simplicity and affordability. The findings indicate that this semi-automatic approach offers an optimal balance between manual labor and fully automated cryogenic systems, making it highly suitable for small and medium enterprises (SMEs) in the rubber manufacturing sector.

Keywords: Pneumatic Deflashing; Rubber Molding; Semi-Automatic Machine; Small Scale Production; Flash Removal

How to Cite This Article

Saundane, A. B., Shaikh, T. H., Dasade, R. N., Gorane, P. S., & Raundal, V. B. (2026). *Design and development of a rubber component deflashing machine for small scale production*. *International Journal on Advanced Computer Theory and Engineering, 15*(2s), 327–332.

Introduction

Background

Rubber molding is a fundamental manufacturing process widely employed across numerous industries including automotive, aerospace, electronics, and consumer goods. The process involves shaping raw rubber material into desired forms using molds under controlled conditions of temperature and pressure. Despite advances in molding technology, the formation of excess material known as "flash" remains an inherent challenge in the rubber molding process. Flash occurs when rubber material escapes from the mold cavity and solidifies in the parting lines or vent areas of the mold.

The presence of flash on rubber components not only affects the aesthetic appearance but can also compromise functional requirements such as sealing capabilities, dimensional accuracy, and overall product performance. Consequently, flash removal or "deflashing" constitutes a critical post-molding operation that directly impacts product quality and manufacturing efficiency.

Problem Statement

Small-scale rubber manufacturing industries predominantly rely on manual methods for flash removal, utilizing handheld cutting tools or knives operated by skilled workers. This approach presents several significant limitations:

- Time-consuming operations resulting in low production throughput
- Inconsistent quality due to human error and operator fatigue
- High labor costs and dependency on skilled workforce
- Safety hazards associated with manual cutting operations
- Difficulty in maintaining uniform product specifications

While cryogenic deflashing and fully automated systems exist, their high capital investment and operational costs make them economically unviable for small and medium enterprises (SMEs) with limited production volumes and budget constraints.

Project Objectives

This research project aims to address the identified gaps by developing a cost-effective, semi-automatic deflashing machine with the following specific objectives:

- Design and fabricate a pneumatically actuated deflashing mechanism suitable for small-scale production environments
- Develop a custom cutting die system adaptable to various rubber component geometries
- Achieve consistent deflashing quality with reduced cycle time compared to manual methods
- Ensure operational safety and ease of use for semi-skilled operators
- Maintain affordability to enable adoption by small-scale manufacturers

Significance of the Study

The development of this semi-automatic deflashing machine holds significant practical importance for the rubber manufacturing industry, particularly for SMEs. By bridging the gap between labor-intensive manual methods and expensive automated systems, this research contributes to enhancing productivity, improving product quality, and promoting worker safety in small-scale production facilities. The findings and design methodology can be adapted and extended to similar manufacturing challenges across related industries.

Literature Review

Overview of Deflashing Methods

The rubber manufacturing industry has developed various deflashing techniques over the decades, each with distinct advantages and limitations. Understanding these methods provides essential context for the development of improved solutions.

Manual Deflashing

Manual deflashing represents the most basic approach, involving operators using knives, scissors, or specialized cutting tools to remove flash from molded components. While this method requires minimal capital investment, studies have consistently shown that it suffers from poor repeatability, high labor costs, and significant safety concerns. Research by Kumar et al. (2019) demonstrated that manual deflashing cycle times vary by up to 40% between operators, directly impacting production planning and quality consistency.

Cryogenic Deflashing

Cryogenic deflashing utilizes liquid nitrogen to freeze rubber components, making the flash material brittle and susceptible to removal through tumbling and media blasting. This method offers excellent results for complex geometries and delicate parts. However, Sharma and Patel (2020) noted that cryogenic systems require substantial initial investment (typically exceeding $100,000), specialized infrastructure for nitrogen handling, and high operational costs, limiting their applicability for small-scale operations.

Mechanical and Automated Deflashing

Mechanical deflashing systems employ various cutting, grinding, or trimming mechanisms to remove flash. Fully automated systems integrate robotics and vision systems for precision operations. While highly effective for high-volume production, Deshmukh (2021) observed that the complexity and cost of such systems often exceed the requirements and budgets of small-scale manufacturers.

Pneumatic Systems in Manufacturing

Pneumatic systems have found widespread application in manufacturing automation due to their reliability, cost-effectiveness, and ease of maintenance. Compressed air-powered actuators offer precise control, rapid response, and inherent safety advantages in industrial environments. Research by Singh and Reddy (2018) demonstrated that pneumatic systems provide an optimal balance of performance and affordability for small-scale manufacturing applications.

Research Gap

The literature review reveals a significant gap in available deflashing solutions for small-scale rubber manufacturers. Existing methods either require excessive labor (manual) or involve prohibitive costs (cryogenic and fully automated). There is a clear need for an intermediate solution that combines the affordability of manual methods with the consistency and efficiency of automated systems. This research addresses this gap by developing a semi-automatic pneumatic deflashing machine specifically designed for small-scale production environments.

Methodology

Research Design

This research employed an experimental design approach encompassing conceptual design, detailed engineering, fabrication, and performance evaluation. The methodology followed a systematic product development cycle with iterative testing and refinement phases.

Machine Design and Components

Frame Structure

The machine frame was constructed using mild steel square tubes (50mm x 50mm x 3mm thickness) welded together to form a rigid structure. The frame dimensions were determined based on ergonomic considerations and the maximum size of rubber components to be processed. The design **incorporated mounting provisions for pneumatic components and die fixtures.**

Pneumatic System

The pneumatic system comprised the following key components:

- Pneumatic cylinder: Double-acting cylinder with 50mm bore diameter and 100mm stroke length, providing adequate force for flash cutting
- Push-button valve: 5/2 way directional control valve for operator-initiated actuation
- Air filter-regulator-lubricator (FRL) unit: For clean, regulated, and lubricated air supply
- Flow control valves: For adjusting cylinder speed to optimize cutting action
- Pressure gauge: For monitoring operating pressure (set at 4-6 bar)

Cutting Die Assembly

A custom cutting die was designed and fabricated from tool steel (HCHCr) with hardened cutting edges. The die geometry was tailored to match the specific rubber component profile, ensuring clean flash removal without damaging the part. The die mounting system allowed for quick changeover to accommodate different component types.

Data Collection Methods

Performance evaluation was conducted through systematic data collection encompassing:

- Cycle time measurement: Recording the time required for complete deflashing operations using stopwatch timing
- Quality assessment: Visual inspection and dimensional verification of deflashed components
- Operator feedback: Structured questionnaires administered to operators regarding ease of use and safety
- Comparative analysis: Direct comparison with manual deflashing operations for identical components

Sample Size and Testing Parameters

Testing was conducted using a sample size of 200 rubber components, divided equally between manual and machine deflashing operations. Components were selected to represent typical production variations in flash thickness and geometry. Testing parameters included operating pressure (4-6 bar), cutting speed (controlled via flow valves), and component positioning accuracy.

Results And Findings

Performance Metrics

The developed pneumatic deflashing machine was subjected to comprehensive performance testing. The following results were obtained through systematic evaluation:

Cycle Time Comparison

Comparative analysis revealed significant improvements in processing time. The average cycle time for manual deflashing ranged from 45-60 seconds per component depending on operator skill and component complexity. In contrast, the semi-automatic machine consistently achieved cycle times of 12-18 seconds per component, representing a reduction of approximately 70% in processing time.

Quality Consistency

Quality assessment was performed through dimensional measurement and visual inspection. Machine-deflashed components demonstrated significantly lower variation in critical dimensions, with a standard deviation reduction of approximately 65% compared to manual deflashing. Visual defect rates (nicks, incomplete flash removal, surface damage) decreased from 8.5% for manual operations to 1.2% for machine operations.

Operational Observations

During extended operation, the machine demonstrated reliable performance with minimal maintenance requirements. The pneumatic system maintained consistent pressure and actuation speed throughout the testing period. Operators reported reduced physical fatigue and improved job satisfaction compared to manual deflashing tasks.

Cost Analysis

Preliminary cost analysis indicates that the total fabrication cost of the machine (approximately $800-1000) can be recovered within 3-4 months through labor cost savings and increased productivity, assuming typical small-scale production volumes of 500-1000 components per day.

Discussion

Interpretation of Results

The experimental results validate the effectiveness of the semi-automatic pneumatic approach for rubber component deflashing. The achieved 70% reduction in cycle time directly addresses the primary objective of improving production efficiency. This improvement can be attributed to the consistent actuation force and precise cutting action provided by the pneumatic system, eliminating the variability inherent in manual operations.

The significant improvement in quality consistency (65% reduction in dimensional variation) demonstrates that the machine successfully addresses the repeatability challenges associated with manual deflashing. The custom-designed cutting die ensures uniform flash removal across all components, regardless of operator factors.

Connection with Research Questions

The research objectives established in the introduction have been successfully addressed:

- Objective 1 (Design and fabricate): The pneumatic deflashing mechanism was successfully designed, fabricated, and integrated into a functional system
- Objective 2 (Custom cutting die): The interchangeable die system accommodates various component geometries as demonstrated during testing
- Objective 3 (Consistent quality): Results confirm consistent deflashing quality with significantly reduced cycle times
- Objective 4 (Safety and ease of use): Operator feedback and observation confirm safe and intuitive operation
- Objective 5 (Affordability): The total cost remains well within reach of small-scale manufacturers

Comparison with Literature

The results align with findings from Singh and Reddy (2018) regarding the suitability of pneumatic systems for small-scale manufacturing applications. The performance improvements achieved are consistent with the theoretical advantages of mechanized operations over manual methods as documented by Kumar et al. (2019). The cost-effectiveness of the solution addresses the gap identified in the literature between manual and cryogenic/automated systems.

Conclusion

Summary of Findings

This research has successfully designed, developed, and tested a semi-automatic pneumatic deflashing machine for small-scale rubber component production. The key findings of this study are:

- The developed machine achieves approximately 70% reduction in deflashing cycle time compared to manual methods
- Quality consistency improved significantly with 65% reduction in dimensional variation
- Defect rates decreased from 8.5% to 1.2%, indicating superior flash removal accuracy
- The machine design ensures operator safety and ease of use for semi-skilled workers
- The total cost of fabrication ($800-1000) makes the technology accessible to small-scale manufacturers

Key Takeaways

The semi-automatic pneumatic approach offers an optimal solution for small-scale rubber manufacturers seeking to improve productivity without the high investment required for fully automated systems. The modular design allows for adaptation to various component types, and the use of standard pneumatic components ensures easy maintenance and availability of spare parts.

Limitation

The following limitations should be considered when implementing this technology:

- The machine requires a continuous compressed air supply, which may necessitate installation of an air compressor if not already available
- Die changeover is required for different component geometries, adding setup time for product changeovers
- The current design is optimized for specific component sizes and may require modification for significantly larger or smaller parts
- Operator training is required for safe and effective machine operation

Future Research Directions

Based on the findings and limitations identified, the following areas are recommended for future research and development:

- Integration of automated feeding mechanisms to further reduce operator involvement and increase throughput
- Development of adjustable die systems to accommodate a wider range of component sizes without changeover
- Investigation of sensor-based quality monitoring for real-time defect detection
- Exploration of energy-efficient pneumatic circuit designs to reduce compressed air consumption
- Adaptation of the design for other post-molding operations such as trimming and finishing

References

1. Kumar, A., Sharma, R., & Patel, V. (2019). Comparative analysis of manual and automated deflashing methods in rubber manufacturing.*International Journal of Manufacturing Technology, 45*(3), 234-248. https://doi.org/10.1016/j.ijmt.2019.03.012
2. Sharma, P., & Patel, D. (2020). Cryogenic deflashing technology: A comprehensive review.*Journal of Rubber Research, 23*(2), 156-171. https://doi.org/10.1007/s42464-020-00058-3
3. Deshmukh, S. (2021). Automation in rubber component manufacturing: Challenges and opportunities for SMEs.*Industrial Engineering Journal, 50*(4), 89-102.
4. Singh, K., & Reddy, M. (2018). Pneumatic systems in small-scale manufacturing: Performance evaluation and optimization.*International Journal of Advanced Manufacturing Systems, 15*(1), 45-58. https://doi.org/10.1504/IJAMS.2018.090123