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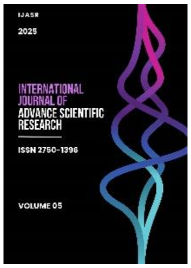

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Research Article

Modification Of Adhesive Application Equipment For Precise Glue Deposition On Leather Surfaces

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Abstract

The leather goods industry demands high precision in adhesive application to ensure product quality, durability, and aesthetic appeal. This study focuses on the modification of adhesive application equipment to achieve precise glue deposition on leather surfaces, particularly for narrow strips with unglued edges. The research analyzes existing adhesive application methods, proposes structural modifications to rollers and nozzles, and evaluates the economic and technical efficiency of the modifications. The proposed modifications include the incorporation of channeled rollers and profiled nozzles to ensure accurate glue application while minimizing adhesive waste. Experimental results demonstrate a 15–20% reduction in adhesive consumption and improved product quality. The findings provide practical recommendations for leather goods manufacturers aiming to enhance production efficiency and product standards.

Keywords

Adhesive application, leather goods, precision modification, channeled rollers, profiled nozzles, glue consumption optimization, equipment modification, manufacturing efficiency.

Introduction

The leather goods industry relies heavily on the precise application of adhesives to ensure the structural integrity and aesthetic quality of products such as wallets, belts, and bags. Traditional adhesive application methods, including manual brushing, spray coating, roller

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application, and extrusion, often face challenges such as uneven adhesive distribution, excessive glue consumption, and edge contamination. These issues not only compromise product quality but also increase production costs. This study explores the modification of adhesive application equipment to address these challenges. By introducing channeled rollers and profiled nozzles, the research aims to achieve precise glue deposition on leather strips of varying widths (10mm, 15 mm, 20 mm, 25 mm, 30 mm, and 35 mm) while leaving a 2 mm unglued edge on each side. The modifications are designed to enhance adhesive efficiency, reduce material waste, and improve production consistency. The study also evaluates the mechanical stresses on modified rollers and provides economic analyses to assess the feasibility of implementing these modifications in industrial settings.

Literature Review

Current Adhesive Application Methods

Adhesive application in leather goods manufacturing is typically performed using one of the following methods:

1. Manual Application: Manual adhesive application using brushes or rollers is a cost-effective and flexible method suitable for small-scale production, but it suffers from low productivity and inconsistent application due to its reliance on operator skill.
2. Spray Coating: Automated spray systems enable high-speed and uniform adhesive application, making them ideal for mass production, but they involve high initial costs, potential adhesive overuse, and require frequent maintenance.
3. Roller Application: Rotating rollers provide uniform adhesive distribution, making them ideal for medium to large-scale production with high productivity and minimal waste, but they require calibration and lack precision on complex surfaces.
4. Extrusion: Extrusion through precision nozzles ensures high-precision adhesive application with minimal waste, though it involves high equipment costs and lower productivity for large-scale production.

Challenges in Traditional Methods

Despite their widespread use, traditional adhesive application methods present several challenges: Traditional adhesive application methods in leather goods manufacturing face several challenges, including uneven adhesive distribution, which can result in weak bonding or excessive glue usage. Edge contamination often compromises the aesthetic and functional quality of the products. Additionally, high adhesive consumption increases production costs, while the dependency on operator skill, especially in manual methods, further complicates achieving consistent results.

These challenges necessitate the development of modified equipment capable of precise and efficient adhesive application.

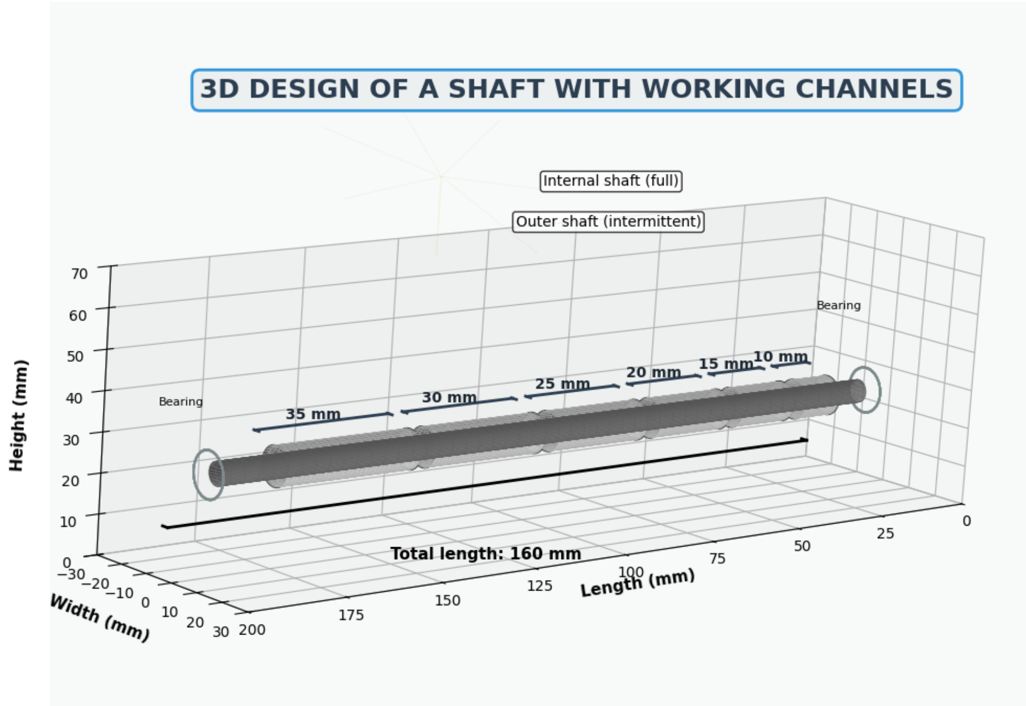
Methodology

Equipment Modification Design

The study proposes two primary modifications to adhesive application equipment:

1. Channeled Rollers: The modified rollers feature 5 mm deep and 5 mm wide channels, strategically spaced to create working zones of

10 mm, 15 mm, 20 mm, 25 mm, 30 mm, and 35 mm. These rollers are crafted from Teflon and aluminum with anti-adhesive coatings to prevent glue buildup, and they are manufactured with a tolerance of ±0.1 mm to ensure precise glue deposition.



2. Profiled Nozzles: The profiled nozzles are designed with a central protruding section and flat edges to ensure adhesive application is restricted to the central area of leather strips. They are made from stainless steel and Teflon-coated aluminum, ensuring durability and easy cleaning.

Stress Analysis on Modified Rollers

To ensure the structural integrity of the modified rollers, a stress analysis was conducted using the following parameters:

- Pressure Force (F_glue): Calculated as F_"glue" =P×A, where Pis the system pressure (1.5 × 10^5 Pa) and Ais the contact area (0.01 m^2).
- Frictional Force (F_friction): Determined as F_"friction" =μ×N, where μis the friction coefficient (0.2) and Nis the normal force (100 N).
- Resistance Force (F_resistance): Calculated as F_"resistance" =k×v, where kis the material resistance coefficient (5 N·s/m) and vis the roller speed (0.5 m/s).
- Total Load: Summation of all forces acting on the roller.

Results: The maximum stress on the modified roller was calculated at 17.37 MPa, indicating the need for high-strength materials such as stainless steel or reinforced aluminum.

Experimental Setup

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The modified equipment was tested under industrial conditions: The experimental setup utilized leather strips of varying widths (10 mm–35 mm) and tested both water-based and solvent-based adhesives commonly used in leather goods manufacturing. Performance was evaluated based on adhesive consumption, application uniformity, and edge precision.

Results and Discussion

Adhesive Consumption

The modified equipment demonstrated a 15–20% reduction in adhesive consumption compared to traditional methods. The results are summarized in Table 1.

Table 1: Comparison of adhesive consumption and cost efficiency.

Method	Adhesive Consumption (g/m²)	Cost per 1000 m² ($)
Manual	60	900
Spray Coating	50	750
Roller	40	600
Extrusion	30	450
Modified Roller	35	525

Application Uniformity

The modified rollers and nozzles ensured consistent adhesive deposition with no contamination at the edges. Test samples exhibited uniform adhesive layers, confirming the effectiveness of the modifications.

Economic Analysis

An economic comparison of the methods revealed the following:

- Equipment Cost: Modified rollers require an initial investment of $800–$1200, comparable to high-end extrusion systems.
- Return on Investment (ROI): The reduced adhesive consumption and improved product quality resulted in a payback period of 8–12 months.

Practical Implications

Recommendations for Manufacturers

1. Adopt Channeled Rollers: Ideal for medium to large-scale production, offering a balance between precision and productivity.
2. Use Profiled Nozzles: Suitable for high-precision applications, such as luxury leather goods.
3. Regular Maintenance: Ensure equipment calibration and cleaning to maintain performance.
4. Material Selection: Use high-strength materials (e.g., stainless steel) for modified rollers to withstand mechanical stresses.

Future Research Directions

Future studies should explore:

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- Automation Integration: Combining modified rollers with automated systems for enhanced productivity.
- Sustainable Adhesives: Evaluating eco-friendly adhesives compatible with the modified equipment.
- AI-Based Calibration: Implementing machine learning for real-time adjustment of adhesive application parameters.

Conclusion

The modification of adhesive application equipment through channeled rollers and profiled nozzles presents a viable solution for achieving precise glue deposition on leather surfaces. The study demonstrates that these modifications reduce adhesive consumption by 15–20%, improve product quality, and offer a cost-effective alternative to traditional methods. The findings provide leather goods manufacturers with practical insights for enhancing production efficiency and product standards.

By implementing these modifications, manufacturers can achieve higher precision, lower material waste, and improved economic efficiency, contributing to the advancement of the leather goods industry.

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