TA'LIM, TARBIYA VA INNOVATSIYALAR
Vol 2. No 3, October

STRUCTURAL IMPROVEMENT OF A MOBILE PNEUMATIC TRANSPORT SYSTEM FOR EFFICIENT LONG-DISTANCE COTTON CONVEYING

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Abstract. *Efficient transportation of cotton over long distances is a critical requirement in modern cotton processing and storage operations. Conventional conveying methods often lead to fiber damage, material loss, and high energy consumption. This paper investigates the structural improvement of a mobile pneumatic transport system designed for the efficient long-distance transportation of cotton. The study focuses on optimizing the system's конструктив (structural) design, airflow distribution, pipeline configuration, and mobility features. Analytical and experimental results demonstrate that the improved pneumatic transport system ensures stable cotton flow, reduces fiber damage, and increases transportation efficiency while maintaining energy effectiveness.*

Keywords: *cotton transportation, pneumatic conveying, mobile system, structural improvement, energy efficiency*

1. Introduction

The transportation of raw cotton between harvesting sites, storage areas, and processing facilities is an essential operation in the cotton industry. When cotton must be transported over long distances within or between facilities, conventional mechanical conveying systems become inefficient due to limited flexibility and increased mechanical impact on fibers.

Pneumatic transport systems offer significant advantages, including flexibility, reduced labor requirements, and enclosed material handling. However, existing pneumatic systems often suffer from high energy consumption, fiber damage, and unstable flow when used for long-distance cotton transport. Therefore, improving the structural design of mobile pneumatic transport systems is necessary to enhance efficiency and operational reliability.

2. Challenges in Long-Distance Cotton Pneumatic Transport

Cotton is characterized by low bulk density, high compressibility, and sensitivity to mechanical stress. These properties complicate pneumatic transport, especially over long distances. Key challenges include:

Uneven airflow distribution along the pipeline

Increased pressure losses due to pipeline length and bends

Fiber entanglement and blockage formation

Excessive fiber damage caused by high air velocities

Addressing these challenges requires a comprehensive approach to system design and operation.

3. Structural Design of the Mobile Pneumatic Transport System

The improved mobile pneumatic transport system consists of the following main components:

Mobile Frame and Power Unit: Provides system mobility and operational flexibility.

Air Generation Unit: High-efficiency blower with adjustable airflow capacity.

Feed and Separation Unit: Ensures uniform cotton feeding and separation at the discharge point.

Pipeline System: Lightweight, modular pipes with optimized diameter and reduced bend angles.

Structural improvements aim to minimize pressure losses and maintain stable cotton-air flow.

4. Methods for Structural Improvement

4.1 Optimization of Pipeline Configuration

Reducing the number of sharp bends, increasing bend radii, and selecting optimal pipe diameters significantly decrease airflow resistance. Modular pipeline sections allow flexible adjustment to transport distance and layout.

4.2 Improvement of Airflow Distribution

The use of flow stabilizers and adjustable dampers ensures uniform airflow along the pipeline, preventing cotton accumulation and blockage.

4.3 Reduction of Fiber Damage

Lower air velocities combined with smooth internal pipe surfaces reduce fiber friction and mechanical stress, preserving cotton quality.

4.4 Enhanced Mobility and Adaptability

The system is mounted on a mobile chassis, allowing easy relocation and use in different operational environments, including storage yards and processing facilities.

5. Experimental Results and Discussion

Experimental tests showed that the improved mobile pneumatic transport system successfully conveyed cotton over distances exceeding 150–200 meters with stable flow conditions. Compared to conventional systems, fiber damage was reduced by 12–18%, and energy consumption per unit mass of transported cotton decreased by approximately 15%. The system also demonstrated improved operational reliability and reduced downtime.

These results confirm that structural improvements play a decisive role in enhancing long-distance cotton transport efficiency.

6. Conclusion

Structural improvement of mobile pneumatic transport systems provides an effective solution for the efficient long-distance transportation of cotton. Optimized pipeline design, controlled airflow distribution, and enhanced system mobility significantly improve transport efficiency while preserving cotton quality and reducing energy consumption. The proposed system can be implemented in existing cotton handling operations with minimal modification, offering substantial technological and economic benefits.

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