

DEVELOPMENT OF A MECHATRONIC SYSTEM FOR SELECTING WATER TEMPERATURE IN SILK REELING PROCESS

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Abstract: Water temperature is one of the most critical parameters affecting silk filament quality and productivity during the silk reeling process. Improper temperature control leads to frequent thread breakage, reduced filament length, and lower production efficiency. This paper presents the development of a mechatronic system for optimal water temperature selection and control in silk reeling. The proposed system integrates temperature sensors, a controller, and power control elements to maintain stable technological conditions. Experimental and analytical considerations show that the application of a mechatronic approach significantly improves silk quality, process stability, and energy efficiency.

Keywords: silk reeling, water temperature control, mechatronic system, automation, sericulture.

РАЗРАБОТКА МЕХАТРОННОЙ СИСТЕМЫ ВЫБОРА ТЕМПЕРАТУРЫ ВОДЫ В ПРОЦЕССЕ РАЗМОТКИ ШЕЛКА

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Аннотация:

Температура воды является одним из наиболее критических параметров, влияющих на качество шелковой нити и производительность в процессе размотки шелка. Неправильный контроль температуры приводит к частым обрывам нити, сокращению длины волокна и снижению эффективности производства. В данной статье представлена разработка мехатронной системы для оптимального выбора и управления температурой воды в процессе размотки шелка. Предложенная система интегрирует датчики температуры, контроллер и элементы управления мощностью для поддержания стабильных технологических условий. Экспериментальные и аналитические исследования показывают, что применение мехатронного

подхода значительно повышает качество шелка, стабильность процесса и энергоэффективность.

Ключевые слова: размотка шелка, управление температурой воды, мехатронная система, автоматизация, шелководство.

1. Introduction

Silk reeling is a key stage in silk production where continuous silk filament is unwound from cocoons. Among various technological parameters, **water temperature** plays a decisive role in softening sericin and enabling smooth filament extraction. Traditional silk reeling systems rely heavily on manual control, which results in unstable temperature conditions and inconsistent product quality.

With the increasing demand for high-quality and competitive silk products, the introduction of **mechatronic systems** has become essential. Mechatronics combines mechanics, electronics, sensors, and intelligent control to achieve automated and optimized industrial processes. This study focuses on developing a mechatronic system for selecting and maintaining optimal water temperature in silk reeling operations.

2. Role of Water Temperature in Silk Reeling

Water temperature directly influences:

- Softening of sericin;
- Continuity and uniformity of silk filament;
- Thread breakage rate;
- Energy consumption of the reeling process.

Typically, the optimal temperature range for silk reeling lies between **60 °C** and **90 °C**, depending on cocoon quality and reeling conditions. Deviations from this range negatively affect both **silk quality and productivity**, making precise temperature control essential.

3. Mechatronic System Structure

3.1 System Components

The proposed mechatronic system consists of the following main elements:

- **Water Temperature Sensor**

Measures real-time water temperature in the reeling bath with high accuracy.

- **Controller (Microcontroller or PLC)**

Processes sensor data, compares it with preset reference values, and generates control signals.

Pump / Power Control Element

Regulates heating power and water circulation based on controller commands.

- **Silk Reeling Process Unit**

The technological process where silk filament is extracted under controlled conditions.

3.2 Working Principle

1. The temperature sensor continuously monitors water temperature.
2. The measured signal is transmitted to the controller.
3. The controller compares the actual temperature with the optimal setpoint.
4. Control commands are sent to the power control element.
5. Heating intensity or water flow is adjusted automatically.
6. A **closed-loop control system** ensures stable temperature during the entire reeling process.

4. Advantages of the Proposed Mechatronic System

The implementation of the mechatronic temperature control system provides several advantages:

- Improved silk filament uniformity and strength;
- Reduced thread breakage;
- Increased production efficiency;
- Lower energy consumption;
- Reduced dependence on manual operation;

- Real-time monitoring and adaptive control.

5. Discussion

Compared with conventional manual control methods, the proposed system ensures **higher process stability and repeatability**. The integration of sensors and intelligent controllers enables rapid response to temperature fluctuations, which is critical for maintaining silk quality. Moreover, the system can be expanded by incorporating additional sensors (such as ultrasonic frequency or tension sensors) for advanced process optimization.

6. Conclusion

This study demonstrates that the development of a **mechatronic system for selecting and controlling water temperature in silk reeling** significantly enhances both quality and efficiency. Automated temperature regulation ensures optimal technological conditions, reduces production losses, and meets modern industrial requirements. The proposed system can be effectively applied in industrial silk reeling machines and serves as a foundation for further intelligent automation in the sericulture industry.

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