

**METROLOGICAL ASSESSMENT OF UNCERTAINTY IN COTTON FIBER
MEASUREMENT: COMPARATIVE ANALYSIS AND PRACTICAL ISSUES**

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Introduction. Cotton is one of the oldest and most widely used fiber materials of mankind, and is used as a basic raw material in many industries, especially in fabric production and textiles. The quality, length and other physical properties of cotton fibers have a significant impact on the success of the production process. The length of cotton fiber is one of its important physical properties, which affects the quality of the final product from the initial stages of production. Accurate and reliable measurement of the length of cotton fiber is important for ensuring product quality, reducing uncertainties in production processes and increasing economic efficiency [1-3]. Measurement processes, especially when analyzed metrologically, can introduce a number of uncertainties. These uncertainties vary depending on the measuring instruments, methods and external environmental factors. Identifying and reducing the uncertainties that arise in measuring the length of cotton fibers helps to optimize the production process and improve the quality of the final product. Therefore, it is very important to metrologically assess the uncertainty in measuring the length of cotton fiber and understand how to reduce it.

Methodology. This article analyzes the uncertainties in measuring the length of cotton fiber, considers the advantages and disadvantages of measurement methods, and also aims to conduct a comparative analysis of measurement methods used in the cotton industry, identify sources of uncertainty, and provide practical recommendations [4].

1. Methods for Measuring the Length of Cotton Fiber

There are several methods and technologies for measuring the length of cotton fiber. The correct choice of measurement method plays an important role in reducing uncertainty and increasing the accuracy of results. Micrometric and physical methods are the most commonly used methods for measuring the length of cotton fiber.

Using the micrometric method, the length of cotton fiber is measured with high accuracy. Micrometers, for example, allow you to determine the length of the fiber at the smallest size using optical microscopes or laser technology. This method mainly measures small parts and some difficulties may arise in calculating the total length.

The physical method (Kruwich method) is based on measuring the length of cotton fiber by stretching it with certain forces. This method takes into account the elasticity and elongation properties of the fiber. This method requires more experience and caution, since external factors (e.g., temperature, humidity) can change the length of the fiber.

2. Sources of Uncertainty in Measurement

Uncertainty in measuring the length of cotton fiber comes from several sources. Analyzing uncertainty, identifying its causes, and taking necessary measures are important in improving the efficiency of the production process [5-8].

- Instrumental error: Measurements can be inaccurate if the measuring instruments are worn out or incorrectly calibrated. Instrumental error can be especially significant in micrometers and optical measuring devices.
- Environmental factors: Cotton fiber is particularly sensitive to temperature and humidity. Therefore, measurements should only be made under certain temperature and humidity conditions. Atmospheric changes (e.g., precipitation, humidity changes) can cause uncertainty when measuring fiber length.
- Human factors: The experience and level of attention of the specialist performing the measurement process also cause uncertainty. Incorrect measurement or incorrect recording of results can lead to errors.
- Repeatability of measurement: When repeating the measurement process several times, the results obtained each time may differ from each other. The extent of this difference is analyzed using statistics and is calculated as measurement uncertainty.

3. Comparative Analysis and Methods

When assessing measurement uncertainty, it is important to compare the effectiveness of different measurement methods. In order to reduce errors in the measurement process, it is necessary to compare methods and determine the advantages of several measurement systems.

- Accuracy: The closeness of the measurement method to the true result. Micrometers can provide high accuracy, but sometimes other methods must be used to increase speed and efficiency.
- Repeatability: How close the results obtained are to each other when a measurement is repeated several times. Increasing repeatability improves the reliability of the measurement method.
- Speed and efficiency: Rapid measurements are needed in the production process. Although micrometric methods provide high accuracy, sometimes it is preferable to use other methods to save time and cost.

4. Uncertainty Calculation

Several methods can be used to determine and calculate uncertainty. Using statistics and mathematical modeling, methods for measuring and reducing uncertainty in measurements can be clearly defined. Using cumulative uncertainty, confidence intervals, and statistical analysis, it is possible to get a clear idea of the errors that occur in measurements.

5. Practical Issues and Recommendations

There are a number of practical recommendations for reducing uncertainty in measuring the length of cotton fiber:

- Calibration and verification: Uncertainties can be reduced by regularly checking and calibrating measuring instruments.
- Stabilization of conditions: The measurement process should be carried out in a stable environment, with controlled temperature and humidity.
- Repeated measurements: Uncertainty can be reduced by repeating measurements several times and taking the average value.
- Computer simulation: By creating a simulation of the measurement process, theoretical analysis and uncertainty can be predicted.

Results. As a result, the correct assessment and effective management of the uncertainty in measuring the length of cotton fiber is important not only from a technical but also from an economic point of view. Metrological control and accurate measurement methods play a major role in the development of the cotton industry and its entry into the international market.

Therefore, it is necessary to develop and implement strategies aimed at reducing uncertainties in measuring the length of cotton fiber, and to use advanced technologies.

Conclusion. Metrological assessment of the uncertainty in measuring the length of cotton fiber is of utmost importance in the process of cotton production and processing. The length of cotton fiber is one of the main factors determining its quality, which directly affects the production processes and final product properties. Measurement uncertainties can damage product quality and reduce production efficiency.

As shown in the article, the uncertainty in measuring the length of cotton fiber depends on several factors. Factors such as errors of measuring instruments, human factors, environmental conditions, and measurement repeatability uncertainty affect the accuracy of the measurement. Therefore, in order to ensure high accuracy and reliability in measuring the length of cotton fiber, it is necessary to correctly select the measurement method, constantly check the calibration of the instruments, and maintain stable measurement conditions.

Measurement errors can be minimized by using comparative analysis, statistical calculations, and modeling of uncertainties. There are also effective ways to reduce uncertainty by repeating measurements and coordinating conditions. The correct application of these methods is very important for increasing the efficiency of cotton production, improving product quality, and optimizing technological processes.

In addition, measurement processes can be further improved using computer simulations and new technologies. Reducing the uncertainty in measuring the length of cotton fiber will not only improve product quality, but also increase the economic efficiency of production.

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