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(Review Article)

Artificial Intelligence Based Monitoring of Cold Shaking Incubator: A Review

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Abstract

AI-based monitoring of cold shaking incubators is a growing area of research and development. However, there are currently no specific search results that provide information on AI-based monitoring of cold shaking incubators. Nonetheless, there are various shaking incubators available in the market that offer temperature and shaking control, as well as monitoring features such as temperature sensors and laser tachometers. Some examples of shaking incubators with monitoring features include the Labnet Environmental Shaking Incubator, the TriNEST Microplate Incubator Shaker by PerkinElmer, and the Innova S44i Stackable Incubator Shaker by Eppendorf. The Zhichu shaking incubator is another option that offers accurate temperature control and a double shaking platform. The shaking incubator is an incubator which consists of shaker and heating chamber for incubating and shaking sensitive samples. It replaces two devices, reducing both time and space needed. Both the shaking mechanism and temperature chamber are regulated via microprocessors, which control all sensors for motor speed, temperature and time. It is suitable for biochemistry, microbiology and clinical laboratories in which applications require temperature and shaking treatment. This article presents a novel design of calibration method of shaking incubator by studying the essential metrological parameters of the device. The experimental results show that the calibration method presented in this article can establish the metrological traceability system of shaking incubator in China in order to ensure the accuracy and reliability of the device, which is of great importance for the quality control of the device.

Keywords: incubators, laser, shakers, platform, temperature.

INTRODUCTION

The introduction of AI-based monitoring in shaking incubators offers several advantages, as indicated by the search results. These benefits include real-time analysis of cell growth, maintenance of optimal conditions for different cell types, increased focus on ecological sustainability, and the ability to reduce energy consumption without compromising functionality. Additionally, AI-based monitoring systems enable remote monitoring, early detection of anomalies, and extensive data collection and storage, leading to improved research outcomes and resource utilization. While the specific implementation of AI-based monitoring in cold shaking incubators is not detailed in the search results, the general benefits of AI-based monitoring in shaking incubators are evident. Let's delve into the fascinating world of monitoring cold shaking incubators. These specialized devices play a crucial role in scientific research, particularly in fields like biotechnology, microbiology, and molecular biology. Allow me to introduce you to their features and significance:

1. Shaking Incubator: A shaking incubator is a laboratory instrument designed to incubate and shake samples at precise temperatures and speeds. It facilitates the growth and cultivation of cells, microorganisms, and enzymes. Researchers use it for various applications, including cell culture, protein expression, and biochemical assays.

2. Key Features: Constant Monitoring System (CMS): Ensures precise control over temperature and shaking speed. Beltless Drive System: Minimizes noise and vibration, enhancing the unit's lifespan. Optional Accessories: Available for compatibility with various laboratory vessels (flasks, tubes, dishes, and trays).

Various Types of Ai-Based Monitoring Systems.

1. Innova Series Shakers from Eppendorf: These shakers utilize the VisioNize touch interface, which includes onboard monitoring, user management, and the ability to export data via USB or network integration via Ethernet.

2. Stuart SI500 and SI505 Shaking Incubators: These devices incorporate a state-of-the-art microprocessor that enables accurate, reproducible control of temperature up to 60°C, and the versatile integrated timer can be set from 1 second to 9 days. They also support USB connectivity for long-term monitoring of the incubator temperature via a PC.

3. iEMS Incubator/Shaker from Thermo Fisher Scientific: This high-performance 96-well plate incubator and orbital shaker features temperature

control and orbital shaking capabilities, with temperature uniformity across the plate and sensitivity and specificity for EIA assays.
4. AutoGen Auto Incubator 96: Designed for bacterial cultures and enzyme reactions, this system can incubate and shake up to 16 of AutoGen's tube units to prepare 96 samples at once.
5. Aquila Biolabs LIS (Liquid Injection System): This device can be used to automate the liquid addition within the shaker, eliminating the need to interrupt shaking.

AI Based Monitoring of Cold Shaking Incubator

Implementing AI-based monitoring systems for shaking incubators offers several benefits compared to traditional monitoring methods:
1. Real-time analysis: AI algorithms can continuously analyze cell growth and provide immediate feedback on optimal conditions for different cell types, ensuring better experiment outcomes.
2. Precise temperature control: AI systems can help maintain constant and accurate temperatures, reducing variability and improving reproducibility.
3. Enhanced efficiency: By automating monitoring tasks, researchers can save time and effort while minimizing human error.
4. Improved energy efficiency: AI systems can optimize power consumption, leading to reduced operational costs and a smaller carbon footprint.
5. Early detection of anomalies: AI-powered monitoring can identify abnormalities quickly, enabling timely intervention before problems escalate.
6. Remote monitoring capabilities: AI systems enable remote monitoring of multiple incubators simultaneously, increasing convenience and flexibility.
7. Data collection and storage: AI systems can collect and store extensive amounts of data, facilitating long-term trend analyses and improved decision-making.
These benefits contribute to higher-quality research outcomes, greater productivity, and enhanced resource utilization in laboratories. As AI continues to evolve, so too do the possibilities for innovative solutions in laboratory equipment, including shaking incubators.

The Key Features of AI-Based Monitoring For Shaking Incubators.

The search results do not provide specific information on the key features of AI-based monitoring for shaking incubators. However, they do mention some general features that are important for reliable screening results in incubator shakers, such as temperature uniformity, humidity control, shaking capabilities, data logging, and energy efficiency. AI-based monitoring systems can help maintain these features by providing real-time analysis of cell growth, optimizing temperature control, and reducing energy consumption without compromising functionality. Additionally, AI-based monitoring systems can enable remote monitoring, early detection of anomalies, and extensive data collection and storage, leading to improved research outcomes and resource utilization. While the specific features of AI-based monitoring for shaking incubators are not detailed in the search results, the general benefits of AI-based monitoring in shaking incubators are evident.

Some Common Errors That Can Occur In Shaking Incubators

The search results provide some information on common errors that can occur in shaking incubators, including:
1. Power failure: This can be caused by poor contact, damaged fuse, or other issues with the power supply.
2. Temperature control issues: These can include incorrect temperature settings, damage to the temperature controller or heating tube, or poor circulation of air in the incubator. Abnormal sounds: These can be caused by worn-out oscillation parts or bearing problems.
3. Display issues: These can be caused by power supply issues, poor contact of the power socket, or frequent opening and closing of the incubator door.
4. Motor or belt issues: These can cause the shaking board to not rotate or oscillate properly.
5. Contamination: This can be caused by spillages getting below the shaker platform or rough handling of flasks.
6. Overfilling: Overfilling shake flasks can lead to poor oxygen transfer and mixing, affecting growth and viability
7. Frequent door opening: Frequent door opening can lead to interruptions in shaking motion, sedimentation of cells, and a drop in oxygen transfer rate.
8. Poor cleaning: Poor cleaning can lead to contamination and affect the quality of the data generated during screening.
AI-based monitoring can help prevent some of these errors by providing real-time analysis of cell growth, optimizing temperature control, and reducing the likelihood of human error and oversight. Additionally, AI-based monitoring systems can enable remote monitoring, early detection of anomalies, and extensive data collection and storage, leading to improved research outcomes and resource utilization.

The Advantages of AI-Based Shaking Incubators Include:

Real-time analysis: AI algorithms can monitor cell growth and detect deviations from expected behaviour immediately, allowing for prompt intervention if necessary. Optimal temperature control: AI systems can maintain precise temperature control, reducing variation and promoting reproducibility. Automatic monitoring: AI systems can perform continuous monitoring, reducing the likelihood of human error and oversight. Data

collection and storage: AI systems can gather extensive amounts of data, facilitating long-term trend analyses and improved decision-making. Remote monitoring: AI systems enable remote monitoring, increasing convenience and flexibility.
Energy optimization: AI systems can optimize energy usage by adjusting temperature and shaking settings based on current needs and historical data. Predictive analytics: Utilizing AI algorithms to predict equipment failures and recommend preventive actions to prolong the lifetime of the equipment.
By leveraging AI-based monitoring, researchers can improve the overall reliability and consistency of their experiments, ultimately contributing to higher-quality research outcomes.

Limitations to Using AI-Based Monitoring Systems for Shaking Incubators

While AI-based monitoring systems for shaking incubators offer many benefits, there are also some limitations to consider. One limitation is the cost of implementing such systems, which can be high due to the need for specialized hardware and software. Additionally, AI-based monitoring systems may require significant training and expertise to operate effectively, which can be a challenge for some researchers. Another limitation is the potential for false alarms or errors in the AI algorithms, which can lead to unnecessary interventions or missed problems. Finally, AI-based monitoring systems may not be able to detect all types of errors or malfunctions, and human oversight may still be necessary to ensure the safety and accuracy of experiments.
However, based on existing knowledge, some common limitations could include:
1. Cost: The implementation of AI-based monitoring systems can be expensive due to the need for specialized hardware and software.
2. Complexity: AI systems may require significant training and expertise to operate effectively, which can be a challenge for some researchers.
3. False Alarms: There is a potential for false alarms or errors in the AI algorithms, which can lead to unnecessary interventions or missed problems.
4. Detection Scope: AI-based monitoring systems may not be able to detect all types of errors or malfunctions, and human oversight may still be necessary to ensure the safety and accuracy of experiments.

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