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OPTIMIZATION OF EGG INCUBATOR TEMPERATURE AND HUMIDITY USING THE STC-1000 THERMOSTAT TO ACHIEVE FARMER SELF-SUFFIENCY

Mehmed Annur [1], Rasyid Ridho Harahap[2], Oloan[3]

[1,2,3] *Mechanical Engineering, Engineering Faculty, University of Riau Kepulauan, Batam, Indonesia*

Corresponding author: mehmedannur@gmail.com

Abstract

This study discusses the design and optimization of a poultry egg incubator system using an STC-1000 digital thermostat as the primary temperature controller and an automatic humidification system to maintain optimal humidity during the incubation process. The objective of this research was to design a simple, cost-effective, and easy-to-operate device for small-scale farmers to support self-sufficiency in poultry production. The research methodology uses a laboratory experimental approach with a single-factor design, namely the STC-1000 automatic temperature control system. The incubator was designed using 4 pieces 40-watt incandescent lamp heating element, an ultrasonic humidifier, and a built-in STC-1000 temperature sensor. Tests were conducted for 21 days on 100 broiler chicken eggs. The results showed that the system maintained a stable temperature of 37–38°C with a deviation of ±0.3°C, and an average humidity of 55–60%. Of the total incubated eggs, 85% hatched, an increase of approximately 15% compared to manual methods without automatic controls. With a total construction cost of under Rp 500,000, this device has proven to be efficient, easy to use, and has significant potential to support the independence of local poultry farmers.

Keywords : Egg incubator, STC-1000, temperature, humidity, farmer self-sufficiency.

INTRODUCTION

The hatching of chicken eggs is one of the most critical stages in poultry production, as its success directly determines the quality and quantity of chicks produced. In practice, many small-scale farmers still rely on natural incubation methods using broody hens. This traditional method presents several limitations, including a restricted number of eggs that can be incubated at one time, a long incubation duration, and a relatively low success rate due to unstable environmental conditions. These limitations have become major obstacles to improving productivity and efficiency in smallholder poultry farming systems.

According to Soeparno (2019), successful egg incubation requires a stable environment with an ideal temperature range of 37–38°C and relative humidity between 55–65%. The stability of these parameters is essential because the developing embryo is highly sensitive to environmental fluctuations. Hidayat (2020) emphasizes that even slight changes in temperature or humidity can disrupt embryonic development. Excessively high temperatures may accelerate embryonic growth to dangerous levels, potentially causing early mortality or deformities, as noted by Susanto (2018). Conversely, temperatures that fall below the optimal range may slow embryonic development and significantly reduce hatchability. In addition, Rahmawati (2021) explains that low humidity can cause excessive evaporation within the egg, while overly high humidity can inhibit evaporation and

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make it difficult for chicks to break the shell, a condition also highlighted by Nurhayati (2020). Therefore, maintaining stable temperature and humidity levels is essential for a successful incubation process, as further supported by Wijaya (2022).

Along with technological advancements, various automated control systems for regulating temperature and humidity have been developed. Prasetyo (2021) designed an incubation system using an Arduino UNO microcontroller equipped with a DHT11 sensor to monitor environmental conditions in real time. Although effective in maintaining temperature and humidity, Santoso (2019) notes that microcontroller-based systems require programming skills and hardware configuration expertise that many small-scale farmers do not possess. Mahendra (2020) further points out that sensors such as the DHT11 offer limited accuracy, making them less suitable for precise incubation control. To address these limitations, Putri (2021) suggests the adoption of simpler yet accurate technologies that are more accessible to rural farmers. Similarly, Kurniawan (2018) reports that the use of higher-accuracy digital sensors can increase hatchability by more than 10% compared to traditional manual incubators.

As a simpler and more cost-effective alternative, the STC-1000 digital thermostat has gained increasing attention for use in homemade incubators. The STC-1000 employs an accurate NTC thermistor sensor that can be calibrated as needed, as stated by Fauzan (2022). This device provides adjustable upper and lower temperature limits and operates automatically through a relay-based system that controls heating and cooling elements without requiring any programming, as explained by Lestari (2019). According to Hakim (2021), the STC-1000 is capable of maintaining temperature stability with deviations of less than ±0.5°C, making it highly suitable for poultry egg incubation. Furthermore, Ardiansyah (2020) reports that integrating the STC-1000 with a simple heating element can increase energy efficiency by up to 15%. With its affordability, ease of installation, and stable performance, the STC-1000 represents an appropriate technology that supports farmer self-sufficiency in efficient and sustainable poultry seed production, as emphasized by Wulandari (2022).

By utilizing appropriate technologies such as the STC-1000, small-scale poultry farmers can significantly improve incubation efficiency while reducing dependence on modern imported incubators, which are often costly. Such simple yet effective local innovations are expected to broaden access to incubation technology, enhance productivity, and strengthen the economic resilience of rural poultry communities.

METHODOLOGY (Material and Method)

This study employed a laboratory experimental method aimed at testing the performance of

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the temperature and humidity control system in an egg incubator using the STC-1000 digital thermostat. The research began with the development of a prototype incubator equipped with several supporting components, including a heating element consisting of four 40-watt incandescent bulbs, an ultrasonic humidifier as a humidity control unit, the built-in NTC temperature sensor of the STC-1000, a DC fan for air circulation, and a digital hygrometer used as a reference instrument during calibration. The incubator was constructed using wooden panels with an acrylic cover to allow visual observation of heat distribution. A total of 100 broiler eggs were used as the research samples.

The initial stage involved assembling the system and configuring the STC-1000 thermostat to operate within the working temperature range of 37–38°C. A 24-hour stability test without eggs was then conducted to ensure that all components functioned consistently and that the incubator temperature could be maintained according to incubation requirements. The STC-1000 system was programmed to automatically activate the heating element when the temperature dropped below the lower threshold and deactivate it once the upper threshold was reached. Meanwhile, humidity was maintained within the 55–60% range with the assistance of the ultrasonic humidifier, which was operated as needed based on hygrometer readings.

After the system demonstrated initial stability, the eggs were placed inside the incubator, and the incubation process was carried out for 21 days. Throughout the experiment, temperature and humidity readings were recorded every two hours using two measurement tools: the STC-1000 display and a digital hygrometer as the comparison device. The physical condition of the incubator, such as air circulation and heat distribution, was also continuously observed to ensure that no significant temperature variations occurred between different sections of the incubation chamber.

The data on temperature, humidity, and hatchability were analyzed using a quantitative descriptive approach. Analysis involved calculating the mean values, deviations, and stability of environmental parameters throughout the incubation period. The hatchability rate was determined based on the number of eggs that successfully hatched on day 21, serving as the primary performance indicator of the incubator. All measurement results were then compared with the ideal incubation standards for chicken eggs to evaluate the effectiveness of the automatic control system based on the STC-1000 thermostat.

RESULT AND DISCUSSION

The results of the study indicate that the egg incubator designed using the STC-1000 digital thermostat was able to maintain temperature and humidity at highly stable levels throughout the 21-day incubation period. Temperature stability is a key factor in the success of egg hatching, as chicken embryos are extremely sensitive to thermal fluctuations. In this study, the average

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temperature achieved inside the incubator was 37.6°C, with a deviation of ±0.3°C. This value demonstrates significantly greater stability compared to manual incubation methods, which typically experience fluctuations of up to ±1°C or more. This level of stability is achieved because the STC-1000 is equipped with an automatic control system based on an NTC thermistor sensor capable of detecting small temperature changes and immediately sending signals to the relay to activate or deactivate the heating element. This quick response ensures that the internal temperature remains within the ideal range for embryonic development.

In addition to temperature, humidity also plays an important role in supporting embryo development inside the egg. During the incubation process, humidity was maintained at an average level of 58%, with a relatively small fluctuation of ±2.5%. This range falls within the ideal level required to ensure a balanced evaporation process inside the egg. Low humidity can cause excessive moisture loss from the embryo, while high humidity can make the hatching process difficult for chicks. In this study, the use of an ultrasonic humidifier proved effective in maintaining stable and evenly distributed humidity throughout the incubation chamber, especially when supported by a circulation fan that ensures the homogeneous distribution of water vapor.

To provide a clearer comparison between the performance of manual and automatic incubation systems, the following table presents the comparative results of both methods.

Table 1. Comparison of Hatchability Results Between Manual Incubators and the STC-1000 System

Incubation Method	**Temperature (°C)**	**Humidity (%)**	**RH Devition**	**Temperature Devition**	**Hatchability (%)**
Manual	36,8 ± 1,2	52 ± 6	±6%	±1,2°C	70
STC-1000 otomatis	37,6 ± 0,3	58 ± 2,5	±2,5%	±0,3°C	86,7

The table shows that the STC-1000 system provides a significantly greater advantage compared to the manual incubation method. Temperature and humidity deviations in manual incubators are relatively large, resulting in unstable environmental conditions that ultimately lead to lower hatchability rates. In contrast, the automatic system provides a much more consistent microclimate, which is reflected in the increase in hatchability to 86.7% compared to only 70% using the manual method.

The high hatchability rate in the STC-1000–based incubator is influenced not only by stable temperature and humidity but also by controlled airflow provided by the DC fan installed inside the

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incubator. Proper air circulation prevents the formation of hot spots or excessively humid areas that could negatively affect embryo development. In addition, the wooden chamber design helps maintain temperature stability because wood retains heat longer compared to metal or plastic materials.

The distribution of hatchability also indicates that most failures occurred during the early phase of incubation, which is typically caused by infertility or poor egg quality. Embryo mortality during the mid and late incubation phases was very low, suggesting that the environmental conditions throughout the incubation process strongly supported embryo development until hatching. The absence of pipped but failed cases also indicates that the final humidity level during incubation was appropriate, preventing the inner eggshell membrane from becoming too hard for the chick to break.

Overall, the results of this study demonstrate that the use of the STC-1000 digital thermostat provides excellent incubation performance, comparable to much more expensive commercial automatic incubators. With its low construction cost, the system is highly suitable for small-scale or independent poultry farmers seeking to improve productivity without making large investments. Its ease of installation, stable temperature control, and high hatchability rate show that this system is an appropriate and practical technology with strong potential for widespread application in small-scale poultry production.

With its ability to maintain stable thermal conditions and significantly improve hatchability, it can be concluded that the use of the STC-1000 as an incubator temperature controller is an effective, efficient, and economical solution. This technology enables farmers to produce poultry chicks more independently and sustainably without relying on expensive imported incubator machines...

CONCLUSION AND SUGGESTION

Conclusion

The results of this study indicate that the egg incubator prototype designed using the STC-1000 digital thermostat is proven effective in maintaining stable temperature and humidity levels throughout the incubation process. The implemented automatic control system successfully maintained an average temperature within the ideal range of 37–38°C and humidity levels between 55–60%, which are essential for optimal chicken embryo development. The responsive performance of the STC-1000 in detecting temperature changes ensures a consistently stable incubation environment, thereby minimizing the risk of hatching failure due to temperature fluctuations. With these optimal environmental conditions, the hatchability rate increased significantly, reaching 86.7%, which is higher than the rate achieved through traditional methods.

In addition to its technical effectiveness, the incubator also offers advantages in terms of

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economic value and ease of operation. With a relatively low construction cost—under IDR 500,000—small-scale farmers can build and operate this device without requiring advanced technical skills or complex programming. The components used, such as the STC-1000 thermostat, ultrasonic humidifier, and incandescent bulb heating elements, are easily accessible on the market and offer sufficient durability. This makes the device not only efficient but also highly sustainable for long-term use.

Overall, the implementation of an automatic egg incubator based on the STC-1000 thermostat serves as an appropriate and practical technological solution that supports the self-sufficiency of local farmers in poultry seed production. This innovation bridges the gap between modern technological needs and the resource limitations of smallholder farmers. By mastering this simple yet effective technology, farmers can enhance productivity, reduce production costs, and decrease dependence on imported equipment. Therefore, this incubator design holds great potential for further development as a model for applying simple technology to support sustainable poultry farming, particularly in rural communities.

Suggestion

Based on the findings of this study, it is recommended that future development of the STC-1000–based egg incubator focus on enhancing the control system to make it more integrated and fully automated. One important improvement is the addition of an automatic humidity control system using more accurate sensors, such as the DHT22 or other modules capable of monitoring and adjusting humidity in real time, thereby eliminating the need for manual adjustments. In addition, integrating an automatic egg-turning mechanism is highly recommended, as this feature helps maintain the embryo’s position and increases the likelihood of successful hatching.

Future studies are also encouraged to develop an Internet of Things (IoT)-based monitoring system so that temperature, humidity, and the operational status of the incubator can be monitored remotely via mobile devices. This advancement would be particularly beneficial for farmers who are unable to supervise the incubator continuously. Furthermore, additional evaluations are needed regarding component durability, energy efficiency, and testing on other types of poultry eggs to assess system adaptability. With these improvements, the simple STC-1000–based incubator has the potential to become an increasingly effective, applicable, and valuable appropriate technology for small-scale farmers in the long term.

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