Journal for Technology and Science
Homepage : https://journal.antispublisher.com/index.php/IPTEKS/index
Email : admin@antispublisher.com

e-ISSN : 3047-4337
JOTECH, Vol. 2, No. 3, July 2025
Page 41-48
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Journal for Technology and Science

Design of Plastisol Ink Dryer for T-Shirt Screen Printing with Flash Curing

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DOI : https://doi.org/10.61796/ipteks.v2i2.426

Sections Info

Article history:
Submitted: September 18, 2025
Final Revised: October 21, 2025
Accepted: November 24, 2025
Published: December 17, 2025

Keywords:
Curing
Infrared heater
Ink dryer
Screen printing
Plastisol

ABSTRACT

Objective: *T-shirt screen printing ink drying can be done with various methods and tools such as fans, hair dryers, or heatguns. Although common and easy to do, these methods of drying t-shirt screen printing ink are less effective and efficient because they take a long time and the drying results are uneven. This research aims to make an effective and efficient plastisol screen printing ink dryer with flash curing using the research and development method.* ***Method:*** *This research aims to make an effective and efficient plastisol screen printing ink dryer with flash curing using the research and development method.* ***Results:*** *The results showed that the drying process with the tool made took 20 seconds for each shirt, 5 seconds faster than the ink drying test with the manual method. The tool made uses a synchronous motor to move the infrared heater forward and backward so that the ink drying results can be evenly distributed.* ***Novelty:*** *This research aims to make an effective and efficient plastisol screen printing ink dryer with flash curing using the research and development method.*

INTRODUCTION

The growth rate of Indonesia's economy in the manufacturing industry continues to increase [1]. According to data released by the Central Bureau of Statistics (BPS), the average growth of the manufacturing industry was 4.2% during 2015-2019, then rose to 4.64% in the fourth quarter of 2023 [2]. This growth is an achievement that can sharpen the competitiveness of the Indonesian industry in business competition among ASEAN countries and globally [3].

Among the many sectors, one manufacturing industry sector that is flourishing among the public is the Textile and Textile Products (TTP) industry [4]. CV Jalan Pintas T-shirt screen printing is one of many home-based textile industry players operating in the Krian area. During the production process, CV Jalan Pintas utilizes the screen printing technique with plastisol ink. After the screen printing process, the ink needs to be dried using solar heat energy so that it can adhere well to the t-shirt [5]. Until now, the drying process has been carried out using a screen printing dryer, commonly referred to as curing [6].

Since its establishment, the screen printing ink drying process at CV Jalan Pintas still uses conventional techniques where an operator directs a heat gun or hairdryer at freshly screen-printed t-shirts. This process takes a considerable amount of time, results in a limited number of dried products, and carries the potential for workplace accidents due to the operator's unchanging body position for extended periods while directing the heat gun or hairdryer at the t-shirts [7][8]. To address this issue, there is a need for a tool that facilitates the ergonomic and effective screen printing ink drying process, resulting

in more even, faster drying and increased production output of screen-printed t-shirts. Previous research conducted, such as the creation of an automatic rail driver for the screen printing curing machine using a DC motor and proximity sensor, and research on improving the quality of the curing process using questionnaires to identify important aspects needed by customers for optimal curing, served as a reference for the current research [9][10].

The current research utilizes an infrared heater as the primary heat source, which is a better type of heater compared to halogen heaters [11][12]. Then there is a dimmer as a speed regulator for the synchronous motor, which functions as a forward-backward drive for optimal curing results [13][14].

RESEARCH METHOD

The research utilizes a research and development method by testing the effectiveness of the tool thru various experiments, improvements, and finalization of the tool in order to overcome the problems faced and achieve the final goal where the product functions according to the research objectives [15]. The stages in the research and development method are problem identification (1); literature review (2); design (3); testing (4); improvement (5); and implementation (6).

A. Block diagram

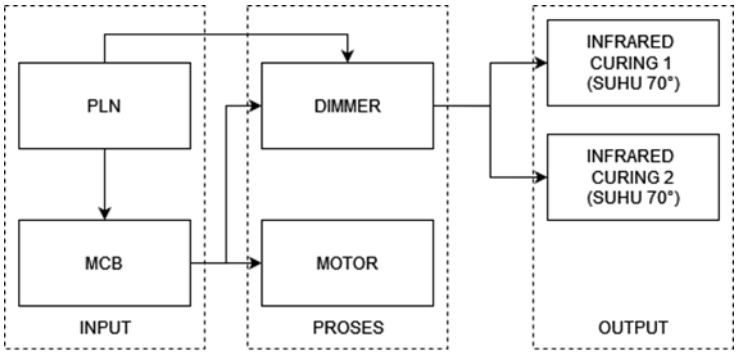

Figure 1. Block Diagram.

The block diagram begins with 220V power input from the PLN (state-owned electricity company) directly to the C6 MCB, which is used to power the dimmer that functions as the speed controller for the synchronous motor moving back and forth. The output consists of two infrared curing units to dry the screen printing ink using heat energy.

B. Wiring Diagram

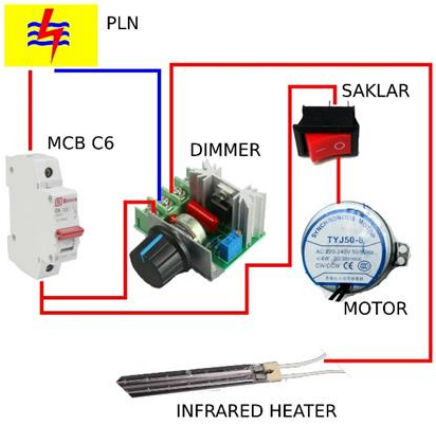

Figure 2. Wiring Diagram.

The wiring diagram starts with the power input from the PLN to the C6 MCB. The output from the MCB is connected to the positive terminal of the dimmer, and the negative PLN (blue wire) is connected to the negative terminal of the dimmer. Additionally, the output from the MCB is also connected to a switch used to control the synchronous motor's operation. The output dimmer is connected directly to the infrared heater.

C. Flowchart

Figure 3. Flowchart.

The flowchart begins when the operator turns on the MCB. Then, the operator adjusts the flame intensity of the infrared heater using the dimmer. The curing process is placed on the fabric that has already been printed with plastisol screen printing ink. Then, heaters 1 and 2 are turned ON at a temperature of 70°C. The operator then turns on the motor using a switch to run the forward and backward process. Infrared heater for active curing process, allowing the heating of screen printing ink on t-shirts to run automatically for 10 seconds until the ink is dry.

D. Ink Drying Process for Screen Printing

The design process begins with screen printing using a 40x60 wooden screen. The screen is placed on the fabric already positioned on the screen printing table and is then squeegeed until the screen printing ink is evenly distributed. Once the fabric has been screen-printed, the ink is dried using a flash cure at a specific temperature until the ink is evenly cured on the t-shirt.

Figure 4. Screen Printing Ink Drying Process.

RESULTS AND DISCUSSION

A. Actual results of the tool

Figure 5. Tool Implementation

The image above shows the realized results of the tool, which is a screen printing ink drying tool or curing machine that utilizes infrared heaters. The heater will move back and forth with the help of a synchronous motor to ensure the heat generated is evenly distributed to the screen-printed t-shirts.

B. Comparison Testing of Curing Equipment with Manual Method

The testing was conducted to determine the speed comparison in the screen printing drying process between the equipment made and the manual method. The testing was performed on six screen-printed t-shirts, and the results can be seen in the table below:

Table 1. Curing Equipment Testing.

Test No.	Synchronous Motor Speed	Drying Duration	Transfer Duration
1	50Hz	20 seconds	3 seconds
2	50Hz	20 seconds	3 seconds
3	50Hz	20 seconds	3 seconds
4	50Hz	20 seconds	3 seconds
5	50Hz	20 seconds	3 seconds
6	50Hz	20 seconds	3 seconds

Table 1 shows the duration in the plastisol screen printing ink drying process using the fabricated equipment, which has a speed of 20 seconds and a stable 3-second transfer for each shirt dried. The total drying time for six t-shirts is 2 minutes.

Table 2. Screen Printing Drying Test Using the Manual Method.

Test No.	Drying Duration	Transfer Duration
1	25 seconds	3 seconds
2	25 seconds	3 seconds

3	25 seconds	3 seconds
4	25 seconds	3 seconds
5	25 seconds	3 seconds
6	25 seconds	3 seconds

Table 2 shows the duration in the process of drying plastisol screen printing ink using the manual method on six t-shirts, resulting in a duration of 25 seconds per shirt. The total time required to dry the screen printing ink using the manual method is 2 minutes and 30 seconds.

Figure 6. Comparison Graph of Drying Duration for Manual Tools and Methods.

CONCLUSION

Fundamental Finding : The curing tool design created has proven to increase the speed and efficiency of business owners in the screen printing ink drying process. **Implication :** Testing conducted showed that in addition to more even screen printing results, the drying duration between t-shirts was significantly improved, allowing t-shirt manufacturers to process more screen-printed t-shirts. **Limitation :** While the curing tool has been shown to increase speed and efficiency, further testing may be needed to determine its performance across different types of screen printing inks and under various environmental conditions. **Future Research :** Future research could explore optimizing the curing tool's design for a wider range of printing processes, including different fabric types, ink formulations, and varying production scales, to ensure its broader application in the screen printing industry.

ACKNOWLEDGEMENTS

The author would like to thank the Electrical Engineering Laboratory of Muhammadiyah University Sidoarjo for their assistance in the research process and report preparation, which allowed the work to be completed successfully.

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