Design of Radiography Film Dryer Machine Using Timer

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ABSTRACT
Drying is the final step of the film processing cycle which aims to remove the water present in the emulsion layer. The result of the film processing is an undamaged emulsion, free from dust particles, crystal deposits, stains, and artifacts. This research aims to make radiography film dryer with a timer. The stages in this research consist of making image designs and selecting tools and materials, the step of assessing the design results of the component system, the final step of qualitative assessment in the form of function tests and verification of the results using machine. Radiography film dyer machine that have been made with length 90 cm, width 20 cm, height 60 cm, with a maximum capacity of 6 films of 35 cm x 40 cm size. Based on the test results, the temperature of the drying film machine is 30°C - 40°C with 1 radiographic film drying faster, the time is approximately 20 minutes. The model of automatic film dryer that is made is still simple, but it can be used to dry films faster than before.

Keywords: *Dryer Machine, Radiography, Design*

1. INTRODUCTION

The use of low energy X-rays in the medical field is often used for radio diagnostics, such as making conventional radiographic images, for example making radiographic images of the head, thorax, abdomen, and others [1]. Radiographic quality is ability of radiographs to provide clear information about the object being examined [2]. The quality of the resulting radiograph is very influential by several factors of irradiation and proper film processing. Film processing consists of several stages, namely developing, rinsing, fixing, washing, and drying. The generation process is influenced by the temperature and duration of the film in the generating solution (developer) [3]. Film-based imaging consists of the interaction of X-rays with electrons in the emulsion film, the production of a latent image, and the processing of a chemical liquid that converts latent image into visible [4]. The latent image will become visible after the film is immersed in a chemical solution that converts silver halide into metallic silver particles [5]. The radiographic film is expected to produce a maximum image in terms of density, contrast, detail and sharpness [6]. Radiographic details describe the sharpness of the image with small radiographic structures [7].

Film processing techniques can be grouped into two, namely automatic and manual. Manual film processing is a washing process or film processing carried out by operators (officers), not using machines. All stages of the film processing are done manually by humans, as well as the time and temperature settings so the possibility of errors is quite large [8]. Meanwhile, the automatic film processing is the film washing process which is carried out automatically by using a machine. The temperature and time at each stage have been set by the system on the machine, so errors that may occur can be reduced. The film processing uses developer liquid, fixer, and water then dried with elements so the film dries faster [9].

Developing is the first step in film processing radiograph. At this stage changes occur as a result of irradiation. Generation is change silver halide grains in emulsion that have been irradiated to become metallic silver or the change from a latent image to a visible image. Rinsing is the next stage after developing. When the film is removed from the generating liquid tank, the

rinsing liquid will clean the film from the generating solution so it does not carry over to the next process. Fixing is required to establish and make the image permanent by removing the silver halide that is not exposed to X-rays [10].

The film undergoes the determination process it will form a silver complex and salt. Washing aims to remove these materials in the water. Drying is the final stage of the film processing cycle. The purpose of drying is to remove the water present in the emulsion. The end result of the film processing process is an undamaged emulsion, free from dust particles, crystal deposits, stains, and artefacts. The most common method of drying is by air. There are three important factors that influence it, namely air temperature, humidity, and air flow through the emulsion [11].

2. METHOD

This research was conducted by using the method of designing machine. After making the machine, then a function test is carried out on the machine to find out the working system of the tool is in accordance with the design. This design research was carried out in August 2020 at radiology laboratory, Stikes Guna Bangsa, Yogyakarta.

The tools and materials used are wooden board, plywood board, aluminium foil, electrical wires, screwdrivers, soldering irons, switches, temperature controllers (thermostat), timers, fans, 600-watt heating elements. The stages in this research consist of the stage of making an image design and selecting tools and materials to be realized into a film dryer machine using timer, the stage of assessing the results of the design of the component system that includes a thermostat (temperature controller), and a timer the final stage is a qualitative assessment in the form of function testing and verification of the results of using the tool. The design of the radiography film dryer machine using timer can be seen in Figure 1.

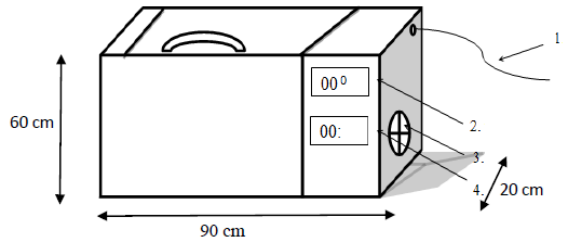


Figure 1. Conceptual design of radiography film dyer machine using timer

The heating element used has a power of 600 watts and an input voltage of 220 volts AC. The process of setting the temperature on the drying system is as shown in Figure 2. The thermostat works as a temperature regulator according to the temperature value setting.

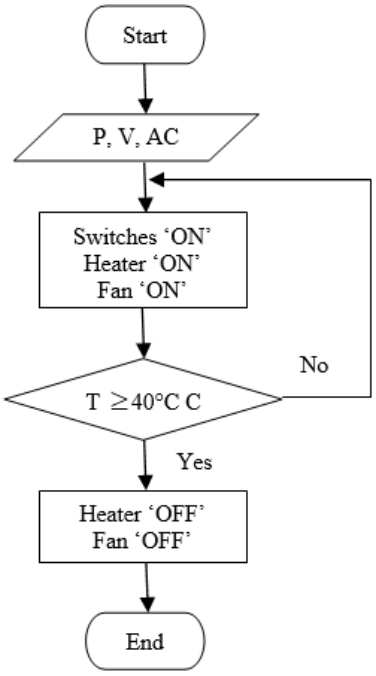


Figure 2. Flowchart of setting the temperature on the radiography film dyer machine using timer

3. RESULTS AND DISCUSSION

Radiography film dryer machine using timer is made according to the conceptual design in Figure 1. First, cut the wooden board to be assembled to form a rectangular box with a length of 90 cm, width 20 cm, height 60 cm. This box is made of wood, plywood boards and aluminium foil. Wooden boards are used on the outside of the box because it is a material that does not conduct electricity, so it is hoped that it will be safer for users. After that, install the fan circuit and heating element into the wooden box. The source of electric current used is AC (Alternating Current) which flows through the socket to control electric current to timer with a voltage of 220 volts. Then from the timer it is connected to the thermostat after which it will go to the heater. Where the heater will be installed between the fan and the film placement space while the fan itself is placed on the right side of the box. Thus, when the box is on, the timer and thermostat will be electrified, otherwise if the box is off, the electric current will automatically cut off. The design of the component X-ray film dryer includes a thermostat, a timer, fan and film hanger stand.

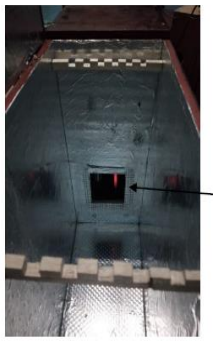
Display machine to be more thorough in providing an overview of the workings of the machine that the author made, then the author conducted a follow-up test, namely the function of machine. The test was carried out by turning on the drying film in the dark room of radiology laboratory. It turns out that the drying film works according to the design that if the on/off button is pressed the thermostat will turn on by itself and if the temperature in the box exceeds 40˚C then the thermostat will

automatically cool down by cutting off the electric current to the hot element.

The results of the machine that has been made into a radiography film dyer machine using timer can be seen in Figure 3. The image from the front view shows that there is a thermostat, switch, timer on the radiography film dyer machine using timer. The thermostat acts as a temperature controller on the machine, the switch is used to turn the machine on and off, while the timer is used to adjust the temperature and time of the film dryer machine. The image from the left side shows a fan and cable. The fan is used to deliver wind from the outside into the film dryer machine using timer, while the cable acts as a path for electric current from the AC source to the film dryer machine using timer. The picture in the box contains a layer of aluminum foil to coat the box and accelerate the heat inside the box when the film is inserted into the film dryer machine using timer. There is a heating element in the box as a space heater in the film dryer machine using timer when the film is heated.

a

b



c

Figure 3. Radiography film dryer machine a. front view b. side view c. interior view

The work principle of the radiographic film dryer is that the temperature controller is set to the desired temperature, the main switch is activated, heater and fan will work. When the set temperature is reached, the heater will automatically turn off and the fan will turn off depending on the time setting. If the drying room temperature has dropped then the heater and fan will be turned on.

Testing the film dryer machine using timer in two ways, namely without film and using film. Machine testing without film serves to find out the machine can run well, the data from machine testing without film can be seen in Table 1. The second method is to dry the radiography film with a size of 35 cm x 40 cm. The test results can be seen in Table 2. Testing on the film dryer by measuring the right temperature where the temperature on the film dryer can be used to dry the film without damaging the film. From the results of tests that have been carried out by researchers with a film dryer machine at a temperature of 40˚C with 1 film, the film will dry faster in approximately 20 minutes. Previously, it had been tested by researchers and laboratory assistants for existing equipment at Radiology Laboratory, Stikes Guna Bangsa Yogyakarta, to dry one film, it took about 35 minutes.

Table 1. The data from machine testing without film

T (°C)	time (minute)
30	5
35	11
40	16

Table 2. The data from machine testing with films

Number of films	time (minute)	time (minute)	time (minute)
	T = 30°C	T = 35°C	T = 40°C
1	30	26	20
2	39	34	27
3	44	39	35

The function test of the radiography film dryer machine without film and with films has been carried out, further testing using a questionnaire. Questionnaires were given to 15 respondents, consisting of radiology lecturers, radiology laboratory assistants and radiology students. For the results of the questionnaire, it can be seen in Table 3.

Based on Table 3 shows 74% of respondents said the shape of the display of the film dryer is very good and 26% of respondents said that the appearance of the dryer was good. For the temperature level of the dryer film, 80% of respondents said it was very good and 20% of respondents said the appearance of the dryer was good. The ease of operation of the film dryer based on the results of the study showed that 100% of respondents said it was very good. With the addition of a digital thermostat timer and heating element based on the results of the study, 66% of respondents said it was very good and 34% of respondents said it was good. The machine does not damage the radiographic film shows 100% of the respondents said it was very good. Based on the results of the questionnaire, it was found that the appearance of the film dryer that has been made is very attractive, not

damage the radiographic film, very easy to operate by beginners and professionals in the radiology field.

Table 3. Questionnaire data of radiography dryer machine using timer test

Description	Very good	Good	Fair	Poor
Radiography film dryer machine display	74%	26%	0	0
Temperature level	80%	20%	0	0
Ease of operation	100%	0	0	0
Timer and thermostat	66%	34%	0	0
Undamaged film	100%	0	0	0

4. CONCLUSION

A radiography film dryer machine using timer has been made, with a length of 90 cm, width 20 cm, height 60 cm, with maximum capacity of 6 films with a film size of 35 cm x 40 cm. The machine made is simple, but it can be used to dry the film faster than the previous machine. The results of the function test show that the working method of radiography film dryer machine using timer is more efficient in drying radiography films, where with 1 film it takes 20 minutes to dry, while the previous machine takes about 35 minutes. Radiography film drying machine using timer needs improvements to the heating system to produce even faster drying times. The interior design can be further expanded to accommodate more films.

AUTHORS' CONTRIBUTIONS

EPA and ANM contributed in study conceptualization, machine testing and writing (review and editing) the manuscript. HE contributed in machine development, testing and writing (original draft). All authors read and agree to the final version of the manuscript.

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