

# The Development of an Eri Cocoon Carding Machine

Kasorn Wongkasem<sup>1\*</sup>, Khemarat Sangloon<sup>2</sup> and Narongtorn Nuaerjunta<sup>2</sup>

<sup>1</sup> Post Harvest Laboratory, Faculty of Engineering, Mahasarakham University, Thailand, 40150

<sup>2</sup> Mechatronics Engineering, Faculty of Engineering, Mahasarakham University, Thailand, 40150

kasorn.wong@msu.ac.th\*, Khemarat.san@msu.ac.th and narongthon.nue@msu.ac.th

**Abstract.** *Eri silk is a natural fiber that can be used to make apparel, textiles and develop value added products. Currently, opening Eri cocoon is done by hands, resulting in high time consuming. Product is not enough to meet the needs of the market. In addition, the fiber has a lower rate of silk fiber dispersion. The objective of this project is to develop a cocoon opening machine to increase the cocoon opening rate and provide a high fiber dispersion rate. The development of an Eri cocoon opening machine has added safety equipment, i.e., the cover of the opening head limit switch to cut off the power during the opening head cover or the control cabinet is open. The experiment is divided into 2 main parts, namely, the experiment of opening head type 1 and type 2. From the experiments, it was found that the second opening head provided the best rate of silk fiber dispersion, with an average of 99.8 percent, the cocoon opening rate of 526 grams per hour and can feed a maximum of 50 grams of cocoons sheet. Based on the results of the experiment, it can be concluded that an Eri cocoon opening machine developed in this project can solve the problem of fibers producing for the mulberry growers.*

Received by 12 August 2019  
Revised by 4 January 2020  
Accepted by 11 January 2020

## Keywords:

Eri , Silk , Cocoon, Carding

## 1. Introduction

Currently, Eri silk is well known and has a high demand in the market due to its excellent heat transfer properties and comfortable wearing. Eri fabric can absorb sweat very well and can prevent dust mites as well. Eri silk can be made into many types of products such as pillowcases, bed sheets, blankets and clothes. In addition, its fibers can be produced as pillows filling, blankets filling and others. Eri fibers are short fibers (staple fiber). To produced yarn, fibers are removed from the nest by spinning. Yarn produced from Eri is then called spun silk [1]. From the price survey of Eri It was found that the price of fresh cocoon is much cheaper than the price of fibers and yarns. The price of fresh cocoons is 7 to 10 US dollars per kilogram. Fiber's price is 50 US dollars per kilogram,

while the yarn has a price of 100 US dollars per kilogram. Typically, the Eri silkworm farmers often sell fresh cocoons to the plant because the fibers production is rather complicated and time-consuming process [2]. The production of normal fibers must wipe the silk cocoon to bring the pupa out. These swollen cocoons will be degumming, which is boiling in the alkali to take the glue or sericin out of the cocoon. The degummed cocoons were then crushed by hand to make the fibers and yarns further.



Fig. 1 : Degummed cocoons and hand crushing process

Fig. 1 shows the degummed cocoons and method of crushing cocoon by hand. According to studies, it has been found that average time spent of the fibers production by hand is 30 seconds per cocoon. Therefore, in one hour, cocoon can be opened about 120 cocoons, which weighs 45 grams. Hence, one kg of cocoons needs time to make fibers about 22.2 hours, which is considered very time consuming.

From the study of related research and equipment used to open cocoon Eri, it was found that the problem was the thorns at the open head are too long. Hence, the opening head cannot open the fiber in order to be regularity [3]. The fibers often gather together on the thorns. Another research, the opening head has the thorns that to short and amount of thrones installed in opening head were too little, so the degummed cocoon was not opened completely. When machine was operated some of fiber blew and stacked with mechanism of machine [4]. Therefore, the aim of this research is to develop an Eri cocoon opening machine that can produce fibers that are arranged in a neat manner and percentage of cocoons that are completely opened by more than 90 percent. The opening rate is not less than 0.5 kilograms per hour to meet the needs of the fiber market.

## 2. Materials and Method

From the survey, it was found that in one day (working 6 hours), the Eri silk-producing farmer could produce silk fiber about 2 kilograms of cocoons. Size of degummed cocoon sheet is about 30 cm wide and 55 cm long. Each sheet weighs about 20 grams. Degummed cocoon is shown in Fig.2. The design of the cocoon opening machine is intended to spread out cocoon to produce a fiber sheet. Cocoon opening machine consists of an important part is Cocoon feeder and head. The thrones installed on head are short, thorny, and arranged in a series of frequencies. Hence, the fibers lumps can be pulled out. In addition, the tilt angle of the head mounted on the head is also important. The research utilized the thorns spawn at a 45 degree to install in opening head of machine.

Cocoon opening machine Eri has been designed and shown as Fig.3. Cocoon opening machine consists of a cocoon feeder tray, a cocoon feeder shaft which is a round shaft steel, a cocoon opening which pulls the fiber apart. After opening, the fiber is cut into sheets. And the last one is the cover. After designed, machine is built and operated.



Fig. 2 : Degummed cocoons

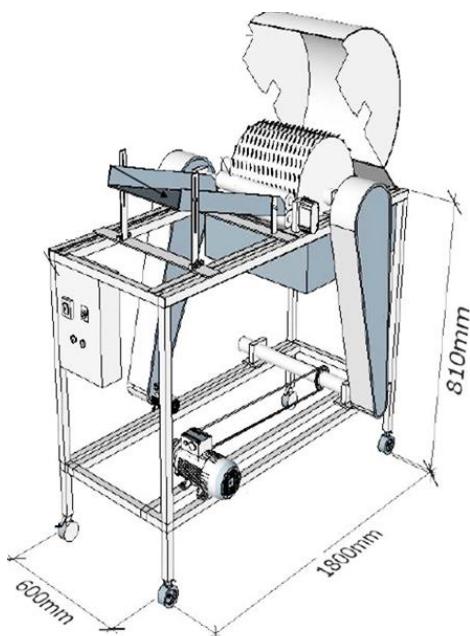


Fig. 3 : Eri cocoons opening machine

## 3. Results and Discussion

The related factors of opening cocoon to find the parameters for high quality fibers production are the preparation of cocoons by degumming. Degum starting from bringing the cocoon to the dishwashing liquid for at least 10 hours, then boiling it with a solution of soap solution mixed with sodium carbonate.

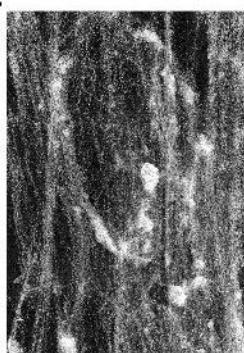
The cocoons were boiled at 90 degrees Celsius for 2 hours. After degumming, cocoons were taken to dry. When the cocoons are dry, it will be taken to open by the cocoon opening machine. Factors related to the quality of cocoon opening are: cocoon loading rate into machine and the number of reopening cycles. In this research, the cocoon feed rate was set to 0.324, 0.486, 0.648, 0.810 meters per minute (2, 3, 4, 5 rpm). The weight of the cocoon sheet used for each experiment was 50 grams. Cocoon sheets size is of 0.3 meters wide. In the experiment, the cocoon sheets were reopened for 1-3 times and repeated three times. The fibers obtained from the opening of the cocoon will be used to determine the cocoon capability of the machine by calculating the percentage of the remaining knot in the silk fiber sheet. Image processing is used to find the knot percentage. The experiment was done by spreading the fibers on the background for scanning the printer model EPSON L 360 with resolution 5760 x 1440 DPI. The algorithm was written to find the size of the knot area relative to the entire fiber area [5].

Fig.4 shows the image of the cocoon fibers obtained from the opening at the speed of the feeder 2, 3, 4 rpm. Fig 5 is a sample image obtained from a fiber scan when the roller's speed is 2 revolutions per minute and the results of the image processing to find the area of knots. The image on the left is a scanned image and the image on the right is the result of image processing.

Based on the results of the experiment of detecting the knot percentage of the fibers, it was found that the cocoon opening machine designed in this research can open the cocoon well, i.e. there are no more than 2 percent of the knot buttons left on fiber.



Fig. 4 : Cocoon fibers obtained from the feeder speed of 2, 3, 4 rpm



**Fig. 5 :** Fiber scanned image and result of image processing

By slowly entering the cocoon into the machine, the rotation rate of the feeder roller is 2 rounds per minute. And the cocoon that was reopened in two rounds and three cycles, it was found that the fibers were distributed almost all and still left knots only 0.228 and 0.193 percent.

#### 4. Conclusions

From the results of the research, it was found that an Eri cocoons opening machine designed and built in this research can produce good quality fibers. The fibers obtained from the machine have very little knot and disperse well. These fibers are ready to be used to make further products such as yarns, pillows, pillows, duvets. It can be seen that this Eri cocoons opening machine can solve the problem of producing Eri fibers for Eri growers.

#### Acknowledgements

The authors would like to thank you to the Faculty of Engineering, Mahasarakham University that provides funding for research and provides scholarships to attend academic conferences.

#### References

- [1] S. Sirimungkararat, T. Sangtamat, W. Saksirirat and Y. Waikakul, "New Food Plants for Eri Silkworm Rearing," *International Workshop on Wild Silkmoths and Silk "Current Advances and Development in Wild Silkmoths and Tropical Bombyx Silks*, Khon Kaen, Thailand, October 11-14, 2014, pp. 63.
- [2] A. R. Horrocks and S. C. Anand, "Handbook of Technical Textiles," Woodhead Publishing Series in Textiles, 2016.
- [3] R. Cholakup, "Yarn Production and Fabric from Eri Mixed with Cotton in Industries," *Report of Research of Development Eri to Industrial Institute of Research and Development of Agriculture and Agro-industry*, Kasetsart University, Thailand, 2005.
- [4] N. Mahachaiyawong, "Process Development/Tools in Yarn Production and Products of Eri Silk, and Optional Market," *Report of Silk-cotton Project*, National Institute of Science Technology, Chaing Mai University, 2001.
- [5] D. Brzakovic and N. Vujovic, "Designing A Defect Classification System: A Case Study," *Pattern Recognition*, Vol. 29, No. 8, pp. 1401-1419, 1996.

#### Biographies



**Kasorn Wongkasem** is currently a senior lecturer and an assistant professor at the Department of Mechatronics Engineering, Mahasarakham University, Thailand.



**Khemarat Sangloon** received his B.Eng in Mechatronic Engineering, Mahasarakham University, Thailand in 2015.



**Narongtorn Nuaerjunta** at has currently work as a research assistant of the Faculty of Engineering Mahasarakham University. He graduated his bachelor's degree in Mechatronic Engineering and his master's degree in Mechanical Engineering, Mahasarakham University, Thailand.