The Development of Cotton-Woolly Decompression Machine with Custom-made Raking Blade operated by Electrical Motor

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Abstract
In textile small-medium enterprises and micro companies that run a business of production and supplying mattresses, a synthetic cotton (cotton-woolly) is a better alternative instead of organic cotton in order to reduce the cost. However in certain conditions, the company needs to additionally process the cotton-woollies in order to get the fluffy property, suitable for mattress substance. A case study in NMH Production & Creation verified that the company managed to decompress only 20% of their per-day-capacity of mattress production (2-3 mattresses per-day) by using a modified cow-food crusher machine. A specific decompression machine; Cotton-Woolly Decompression Machine was proposed by Politeknik Kuala Terengganu researchers with custom-made raking blade and operated by 7.5hp electrical motor which estimated to been completely developed within six months. This machine is expected to daily produce 250 to 300 kg of processed cotton-woollies (10-15 mattresses per-day) which exceeds the company per-day requirement. The safety and efficiency of the machine were also been considered by including a closed-body frame to avoid direct contact to the blades and a control panel with labels in the design.
Keywords: cotton-woolly, synthetic, decompression machine, raking blade, electrical motor

1.0 Introduction

One of the fast pace growing industry in Malaysia is the textile and apparel since early 1980s of export-oriented industrial transformation. Through varied production of greater value-added goods, the industry is currently aiming for higher end of the global value chain (Bernama, 2016, August 16). With the latest automation and technology implemented in its manufacturing and distribution, the industry also commenced new R&D activities and dynamically pursuing business alliance with foreign companies to increase its competitiveness in the global market.

Located at Pusu Tiga, Marang, Terengganu, Malaysia, NMH Production & Creation is a textile micro company that runs a business of production and supplying mattress based on a synthetic cotton; cotton-

woolly. As a newly developed textile company, producing cotton-woolly-based products is a better alternative instead of pure organic-cotton-based products for their cheaper cost. Furthermore, it is quite difficult to find 'kekabu' or 'kapok' tree nowadays, (scientifically-called Ceiba Pentandra) (Figure 1), to provide the pure organic-cotton as it only grows in the remote area of tropical countries and usually not been commercially-planted (Musa, M., 2016 February 28). Instead, cotton-woolly (Figure 2) is synthetic cotton, based on used-fabrics that have been completely crushed through a machinery to replicate almost similar texture to the organic cotton.

(a) (b)

Figure 1: (a) 'kekabu' tree; (b) pure organic cotton 'kekabu'

(a) (b)

Figure 2: (a) Compressed cotton-woolly imported from neighbourhood country; (b) decompressed cotton-woolly

In order to fulfill their raw materials requirement, NMH Production & Creation has imported this cotton-woolly from neighborhood country in large amount of capacity. However, the cotton-woollies provided have been seamlessly packed and compressed inside the cargo (Figure 2(a)) which made them difficult to be decompressed in fluffy form to suit the requirement of mattress production. The company had tried a few methods to decompress the cotton-woolly such as manually ripped off and using the

modified cow-food crusher machine (Figure 3). The first consumed very long time and required too much of efforts. The latter meanwhile managed to reduce time, but still unable to produce exactly the required output and also prone to safety issues.

Figure 3: Modified cow-food crusher machine

Using the modified cow-food crusher machine for decompression purpose, the company managed to decompress only 20% of their per-day-capacity of mattress production. The machine's original function is to crush the animal food such as plant parts by its mechanical teeth crusher's runs by a petrol engine. Subject to the modification made by the company, the petrol engine only manage to last for six months and cost them quite an amount to replace a new traction system.

Within the existing manpower, the company can only produce 2-3 mattresses per-day instead of 10-15 mattresses due to this. The long waiting period for the decompressing process, while producing only a small amount of decompressed cotton-woolly using current method, were such a waste of time and manpower to the company. Furthermore, the company sometimes was enforced to resist the demand from their clients due to inability to fulfill them. Thus, the company requires a new innovation of decompression machine for the cotton-woolly in order to meet their customer demand and to save on operating and manpower costs.

In Research, Innovation and Commercialization Unit, Politeknik Kuala Terengganu, we have done the study to solve the company problem by proposing a new innovation in decompression machine named 'Cotton-Woolly Decompression Machine' (CWDM). The machine is targeted to produce a fluffy texture of decompressed cotton-woolly according to the requirements in higher quantity per-day.

2.0 Development Process of CWDM

The development process of CWDM includes the overall project timeline, focusing on the machine design and some explanations on the mechanical and electrical components.

2.1 The Project Duration

It has been projected that the Cotton-Woolly Decompression Machine (CWDM) can be completed within 5 months of time starting from 1 November 2017 until 1 April 2018 as shown in Table 1. The scope of the project is to design, fabricate, installation and testing of the machine. This paper will only describe on the machine design and testing result.

Table 1: Project Duration

No.	Time / Task	Month				
		Nov '17	Dec '7	Jan'18	Feb '18	Mar '18
1.	Design					
2.	Fabrication					
3.	Installation					
4.	Testing & Commissioning					

2.2 The Design

The design of CWDM consists of four parts; the raking blade, the traction system, the frame and the control panel as illustrated in Figure 4(a) and 4(b). The design has been copyright approved by the Intellectual Property Corporation of Malaysia (MyIPO) with registration number LY2018001007.

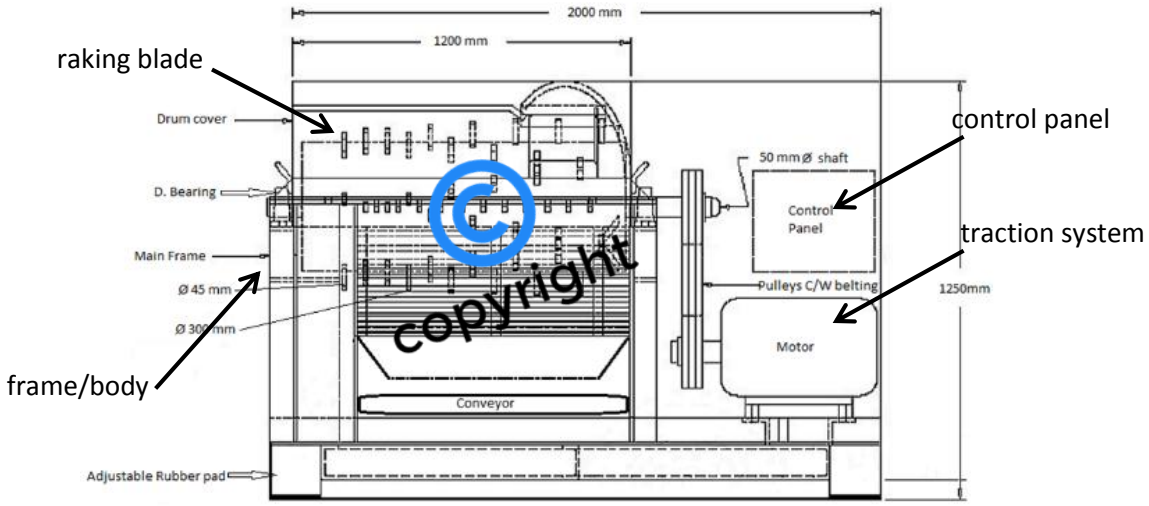

Figure 4(a): CWDM front view

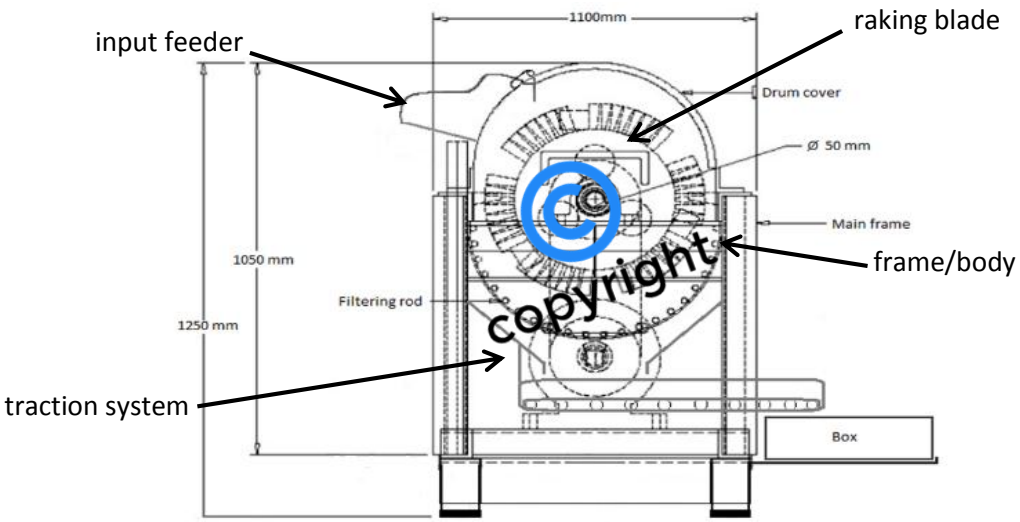

Figure 4(b): CWDM side view

2.3 Raking Blade Construction

The raking blade was custom-made in order to ensure the decompression process of the cotton-woolly is according to the specification. Two type of blades was developed; rotating blades and static blades. Three sets of rotating blades on shaft work together with two sets of static blades on body frame to perform the raking task. All blades are solid metal based.

2.4 Traction System

The prime-mover was the 7.5hp electrical motor to work with pulley and belting connected to the raking shaft. This machine is the 3-phase industrial standard machine that will provide the company with better opportunity to expand their business in future. The machine was able to work continuously and producing output quantity more than the company requirement.

2.5 Frame and Control Panel

The fully closed frame was proposed to provide safety to the machine operator. The input feeder was placed on the top side of the body frame also for the safety purposes. The control panel was attached beside the machine body to facilitate the machine operation by the operator. The motor starter was equipped with star-delta configuration to deal with high starting current of the 3-phase electrical motor.

3.0 Results and Discussion

This section will describe on the development of the machine within the given time and test result in term of the output quality and safety of the design.

3.1 Machine Development

The machine was successfully developed within five months period considering four proposed solutions to the company problem as in Figure 5 below. The final prototype is as shown in the following Figure 6.

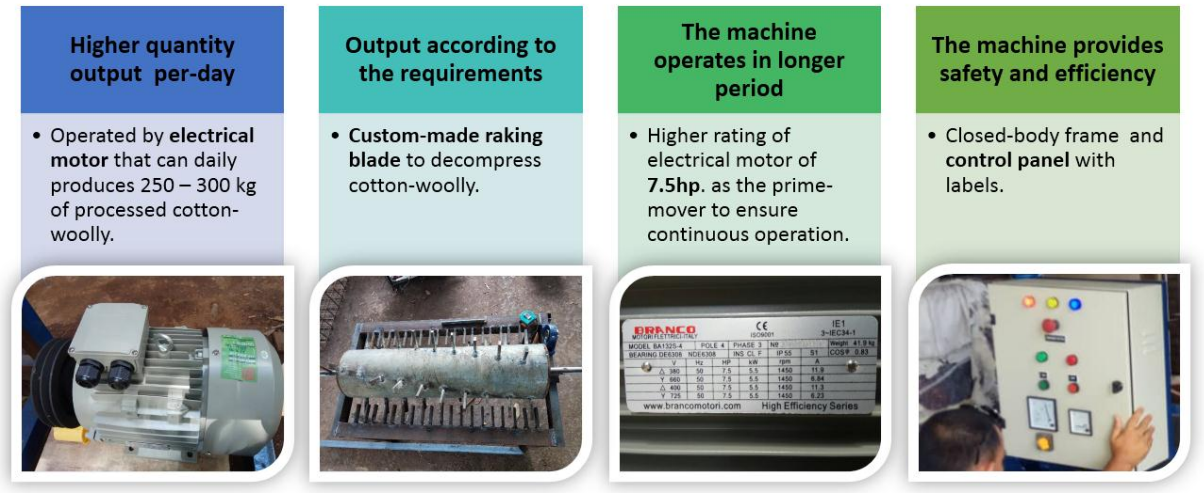

Figure 5: Proposed solution to the company

Figure 6: Final prototype of CWDM

3.2 Test Result

A testing session was performed to the machine with the company availability. From the testing, the machine has been accepted by the company regarding; (1) the output quality of decompressed cotton-woolly, and (2) the safety of the design. The quality of the machine output matched the requirement of the company for mattress substance as shown in the following Figure 7. The processing time is faster than expected; approximately 30 minutes per bulk (100 kg).

(a) (b)

Figure 7: Output test result (a) before; (b) after

4.0 Conclusion

This paper explains the development of Cotton-Woolly Decompression Machine, a new innovation specially invented to solve a decompressing problem of cotton-woolly in NMH Production & Creation. The machine was specifically designed and managed to fulfil the company requirements as proposed; (1) operated by higher rating of 3-phase electrical motor (7.5hp) as a prime mover to ensure continuous operation of the machine and producing a higher daily output quantity (250-300kg), (2) equipped with custom-made raking blade to ensure the output quality is according to the requirements, and (3) designed with closed-body frame and labelled control panel to ensure safety and efficiency of operating. The test has proven that the machine will definitely increase the company productivity of processed cotton-woolly and at the same time reduces the processing cost and time.

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