The Performance Comparison of Two Kinds of Mold-Hot-Press Machine

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ABSTRACT
Research on the development of the second-generation mold-hot-press machine using the Quality Functional Deployment (QFD) Method has been carried out. Furthermore, the performance test of the machine was compared with the first-generation machine. This research aimed to compare the performance of the two generations of the machines. The components of both machines that were evaluated were heater and press. Results showed that the second-generation machine has better performance in both components. The use of LPG heaters in the second-generation machine can expand the range of uses of the machine. This second-generation machine can be used in rural areas without electrical power, as well as the use of screw press on second-generation machines can reduce the level of worker fatigue.

Keywords: *Mold-Hot-Press, Performance, Comparison Test, QFD Method.*

1. INTRODUCTION

Increasing awareness of the environmental and health impacts associated with the production and use of plastic plates gave rise to the idea of producing environmentally friendly plates from natural materials, such as the areca palm (*Areca catechu* L.) sheath [1]. A mold-hot-press (MHP) machine is required to produce an areca sheath plate. In previous research, the first generation MHP machine was successfully built. This machine uses an electric heater and a hydraulic press [2].

The use of an electric heater and the hydraulic press was a weakness of the first generation of MHP machine that must be developed. MHP machine development using the QFD method. QFD is a method for designing products according to customer needs [3]. A good product is a product that meets customer requirements. QFD method can integrate customer requirements into every aspect of the design [4] [5]. Customer needs are a priority for the development of plate mold tools. The development focuses onthe heater and press components [1].

From the results of previous research [1] replaced the electric heater with propane gas (LPG, liquefied petroleum gas) heater, and replaced the hydraulic press with a screw press. This study aimed to compare the performance of the first-generation MHP machines that use electric heating and a hydraulic press with the performance of the second-generation MHP machines that use LPG heaters and screw press. The hypothesis is the performance of the second-generation machine is better than the first-generation machine.

2. METHOD

2.1. Research Objects and Subjects)

This research was conducted at the Workshop of Agricultural Engineering Study Program, Faculty of Agriculture, Jambi University. The object of research was an MHP machine. The research was focused on developing heater and press components. The subjects of filling out the questionnaire were twelve respondents consisting of four areca sheath plate producers, areca palm farmers, and BUMDes managers in *Tanjung Jabung Barat* and *Tanjung Jabung Timur* Districts, Jambi Province.

2.2. Research Procedure

This research was conducted in three stages, namely: design, construction, and testing (Figure 1). The design used the QFD method. This stage aimed to make a

machine design according to customer needs. Construction was carried out in the workshop to produce a machine according to the design. The test aimed to compare the machine performance resulting from this study against the first-generation machine.

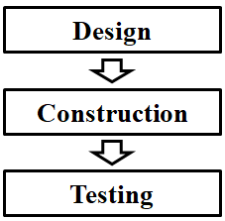

Figure 1 Research Procedure [6]

The measurement of the heater component was based on the energy requirements for heating the mold by the heater. The calculation was based on the equivalent of electric energy (kWh) with propane gas energy (BTU) [7].

1 kWh ≈ 3.412BTU
1 kg Propane ≈ 46.297 BTU
1 kg Propane ≈ 46.297/3.412 kWh = 13,57 kWh

..... (Eq 1.)

The measurement of the press component was based on the measurement of the workers' pulse rate after one hour of work. Work pulse as an indicator to determine the weight or lightness of an individual workload. The heavier the workload, the shorter the individual work time to work without physiological disturbances and other fatigue. Fatigue is a form of metabolism that protects the body from further damage, so that recovery occurs after resting [8][9].

3. RESULTS AND DISCUSSION

3.1. Construction Comparison

The following is a comparison of the construction of the first and second generation MHP machine (Figure 2). The first generation MHP machine uses a heater with an energy source of electric power with a power of 4,000 watts. In contrast, the second generation MHP machine uses a heater with an energy source of propane gas. The second difference is that the first generation MHP machine uses a hydraulic press that is moved manually using the feet for 30 movements. Meanwhile, the second generation MHP machine uses a screw press that is rotated manually by hand for 3 turns (Table 1).

Figure 2 Construction Comparison of Two Kinds of MHP Machine.

Table 1 Technical specifications of MHP Machine

No.	Spesifications	1st Generation	2rd Generation
1.	Dimension		
	- Length (cm)	58	60
	- Width (cm)	17.5 atau 66.5	60
	- Height (cm)	167.5	120
2.	Energy Sources	Electricity	Propane Gas
3.	Press Component	Hydraulic Press	Screw Press
4.	Capacity (units/hr)	30	30

The use of electrical energy sources for heating components causes the MHP Machine unable to be used in rural areas that do not have a source of electrical energy. Meanwhile, the use of manual hydraulic presses causes fatigue for workers who have to press 30 times for each product produced. So, the second generation MHP machine was developed. This machine uses a heat source from propane gas. Currently, propane gas in the form of LPG (liquefied petroleum gas) has been marketed to rural areas. Meanwhile, the use of a screw press is expected to reduce worker fatigue.

3.2. Energy Consumption

Apart from being a solution to the problem of electricity availability in rural areas, the use of propane gas as an energy source is expected to reduce production costs. The following is the calculation of energy prices for the two types of energy sources:

The price of one kg of propane gas is IDR 12,000. The energy from one kg of propane gas is equivalent to 13.57 kWh of electrical energy. The price of electrical energy for the B-2/ TR class (5,501VA – 200 kVA) is IDR 1,444.70/kWh or the equivalent of IDR 19,605 per kg of propane gas (ESDM, 2000). This means that the use of propane gas energy sources can save production costs by 61.21% (Table 2).

Table 2 Production cost

No.	Description	1st Generation	2rd Generation
1.	Energy Source	Electricity	Propane Gas
2.	Energy Consumption	4 kWh	13,648 BTU
3.	Price	IDR 1,444.70 / kWh	IDR 0.2592 / BTU
4.	Production Cost	IDR 5,778.8 / hour	IDR 3,537.5 / hour

3.3. Work Fatique

The work fatigue measurement is based on measuring the worker's pulse after one hour of work. Work pulse as an indicator to determine the weight or lightness of a workload. Table 3 presents the increase in pulse rate after working for one hour.

Table 3 Worker's pulse after one hour of work

No.	Worker's Pulse	1st Generation	2rd Generation
1.	Before Work	80,05	81,50
2.	After Work	88,65	87,45
3.	Difference	8,15	5,95
4.	Standard Deviation	3,30	4,27

Replacement of the hydraulic press with a screw press aims to reduce worker fatigue. The results showed that the use of a screw press increased the pulse rate by 5.95 pulses after one hour of work. Previously, the use of the hydraulic press increased the pulse rate by 8.15 after one hour of work. Thus, replacing the hydraulic press with a screw press can reduce worker fatigue.

4. CONCLUSION

The second-generation machine has better performance in both components. The use of LPG heaters in second-generation machine can expand the range of uses of the machine. This second-generation machine can be used in rural areas without electrical power. The use of screw press on second-generation machines can reduce the level of worker fatigue.

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