Wood Drying Kiln for Indonesian Export Wood Toys and Handicraft Industries

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Abstract:

This research aims to develop wood drying kiln with a capacity of 3 m^3 of timber that suitable for medium and micro scale of wood handicrafts and toys industries. The fuel used is wood waste from the rest of the production. Heat flow in the wood drying chamber through the suction fan that sucks hot air from the combustion chamber into the drying chamber. From this chamber the air is circulated to the suction channel again continuously. In this experiment used rosewood. Wood has water content between 26% - 36%. Heating is carried out for 40 hours at temperature about 50 ° C on the first 4 hours heating and subsequent heating to 80^0C to obtain the expected result of drying. Measuring was done every 2 hours. Measurements at 9 points of wood in the chamber showed that there were 3 variations of water content of wood between 0% - 16%. There are 6 points with 0% water content, 2 points with 4% -6% water contents, and 1 point with 16% water content. The results of these measurements indicate that all dried wood products from this kiln can be used for export quality wood products.

Keywords: kiln, wood, humidity, handicrafts and toys, export

A.INTRODUCTION

Wood craft of toys and handicrafts at Prambanan was originally a community craft designed to meet the needs of souvenirs for domestic and foreign tourists who visited the Prambanan Temple in Yogyakarta. Existence of business groups of wood toys and handicrafts to the environment is very meaningful because it can overcome the effects of unemployment and income generating both for the forest owners and entrepreneurs. Woods that be used for handicraft and toys are teak, mahogany and rosewood. These woods comes from community forests in the mountainous region around the southern part of Java. Although production tools used for making handicrafts and toys so simple, community craft from this area can develop qualified variety of craft production that can be exported to overseas. Figure 1 shows some of their export quality products. The craftsmen were usually processing their fresh log into boards. The boards have water content over 30%. They seldom reduce the water content by solar heating or by the other processes but directly process the boards became handicrafts and toys.

Figure 1. Examples of export quality products

Procedure for making the craft start from developing pattern, sawing, sanding, assembling and then heat them in the sun (see Figure 2) prior to finishing with melamine paint.

Figure 2. Products with sun drying prior to painting

For export oriented, the processes of wood products above will affect the products easy to crack when exported to non-tropical climates countries. Budianto (1996: 13) mentions that the biggest problem of the export-oriented wood processing industry is wood drying. The countries that

import wood products from Indonesia need wood quality with certain water content in order to meet with their market. Wood export products are generally required water content between 5% - 20% depending on the various of products to be made, but if the water content below 8% it will be better because the wood will not be affected by changes of humidity and climate. That is why wood kilns are needed for reducing water content to 8% so that the exported timber products will be stable from cracks. Zykowski (2002) mentions that the timber has a hygroscopic nature which can absorb and release moisture in its body to adjust to the surrounding environment. An understanding of wood characteristics of the water content is very important because it will affect the properties and processed of wood. There are several types of wood kiln like a conventional, dehumidification, solar, and vacuum. (www.nyle.com/downloads/KilnDrying.pdf). Given the woodcraft industries are small medium Enterprises (SME), so that conventional wood kiln is selected. The kiln to be designed in this industry should be able to dry 3 m^3 of wood with wood waste heating energy fuel and electric fan to rotate hot air into the drying room. A homogeneous heat flow in the whole drying room is absolutely necessary in order to obtain the quality of wood with the same water content at each location. The fan sucking hot air from the combustion chamber into the drying chamber serves to distribute heated air evenly to the entire room. The main point of the conventional drying temperature is set to a certain level (60°C - 80 ° C) so that the water in the timber evaporates (www.tentangkayu.com). In traditional systems, the heat comes from a furnace or combustion chamber with wood residue fuel. The heat energy generated by the fire burning and then circulated to the chamber with suction fan. Fan becomes important part in the heat distribution system and wood drying process stabilizer. The positions and number of fans-are arranged so that the distribution of heat in the drying chamber stable. There are some fans that distribute hot vapored water or hot air, another fan in charge of heat circulation in the chamber and removing saturated air outdoors. Saturated air means high moisturizing air content due to water vapor emanating from the timber drying chamber. A good chamber must always be maintained to keep the floors dry and clean, avoid the flow of water. Floors need to be made slightly tilted to the front door so that if there is water flow (usually from the water timber) will flow out of the drying chamber. Drying chamber door should be able to seal the inside air from outside air. For the best results, do not distribute high temperature in the chamber for early process. Distribution of heat is done in stages and periodically. Usually preceded by temperatures around 40^0C-50^0C and then followed by temperatures around 70^0C-

80^0C in midle till the end process. This temperature must be maintained so that no heat changed drastically happened in the short a time. Therefore the kiln requires 24 hours supervision for keeping the heat distribution.

Design of dry kiln is an art that requires field testing, feedback from users and experience for the design improvement. Dry kiln design is done by trial and error based on previous experience. Budynass (2008) provides the design of a product must consider the factors function, strength, stiffness, wear, corrosion, security, reliability, easy to be made, usability, price, friction, weight, age wear, noise, model, shape, size, thermal properties, surface, lubrication, marketing, maintenance, volume, responsibility, and easy to be developed again. Pahl, et al (2007: 77-103) provides a method of solving the problem either by using conventional methods, intuitive methods, discursive methods, and methods for combining solutions.

B. MATERIALS AND METHODS

1. Procedure Conducting the Program

The researchers discuse to determine the solution of the exist problems with the Industries. Offered solutions include designing and developing wood kiln with suction fan that driven by 3/4 HP electric motor. Selection is based on the installed electric power industry up to 5000 watts and the heavy duty of suction fan. The steps taken include:

a. Design the kiln with a 3 m^3 wood capacity which using ¾ HP electric motor power with a speed of 1425 rpm to rotate the fan sucking hot air from the combustion chamber into the drying chamber.

b. Realize the design by doing it in the workshop

c. Test the performance of wood kiln with the industry to obtain required results.

d. Handed over responsibility for the installed kiln to the industry.

e. Test the wood kiln in actual production conditions and report the results to the researchers.

f. Repairs and improvements for optimal performance.

g. Monitor performance of the kiln periodically

2. Selection of Small Medium Enterprises (SME)

SMEs "*AGUNG* Handicraft" was founded in 1996. Located at Klurak Baru Village, District Prambanan, Sleman, Yogyakarta, the industry formerly made its own wood crafts and then marketed to the tourist location such as Prambanan Temple, Ratu Boko, Malioboro city center, and traditional markets for regional tourist such as Borobudur Temple Magelang. In its development, the company progressed continuously. As a result, since 2002, the industry been able to export the wood craft product. Number of employees is highly depended on the order made by the buyers. The number of employees is between 15-40 people every day. The woodcrafts are made of teak, mahogany, and rosewood. This wood partly derived from local materials. The material prices (still in the form of logs) ranges between Rp. 80,000 – Rp. 100,000/ 3 m^3. This material can be developed into many products with value between Rp. 4,000,000 – Rp. 6,000,000. Production capacity is about 1,000 - 2,000 units per month. The products are various such as: bicycle, tricycle, motorcycle such as Vespa, Norton, Harley Davidson, airplanes, trucks, horse cart, rickshaw, and others.

SMEs" *INOE* Handicraft "was established in 1996 in Pemukti Baru, Tlogo, Prambanan, Klaten, Central Java. The industry produces handicrafts made of rosewood, teak, and mahogany. The products have been exported to many countries such as Australia, Turkey, Spain, France, England, Holland, America, Canada, and others. The number of employees the company is also influenced by the orders. Employees who work at this company are between 15-25 people. Production capacity is about 1600 units per month. The company's products are almost entirely handmade products toys such as: butterflies, animals, letters, toy cars, fish, and others. At the final stage, all products be controlled for passing quality assurance standard.

3. Materials and Spesific tools

a) To make the kiln, materials and tools parts that available on an industrial site are employed. This method is taken for easily replacing part reason.

b) The materials that be used are steel profiles, elbow, mild steel plate, strip plate, zinc plate, hinge, carbon steel shaft, ball bearings, galvanized pipe, nuts and bolts, pulleys, transmission belts, thermometer, ¾ HP electric motor.

c) The tools that be used are lathes, welding machines, drilling machines, guillotine, cutting machines, mechanical cutting machines, cutting grinders, grinders, screw taps, spray gun tool set.

4. Kiln design, performance and productivity.

Designed kiln can be seen in Figure 3.

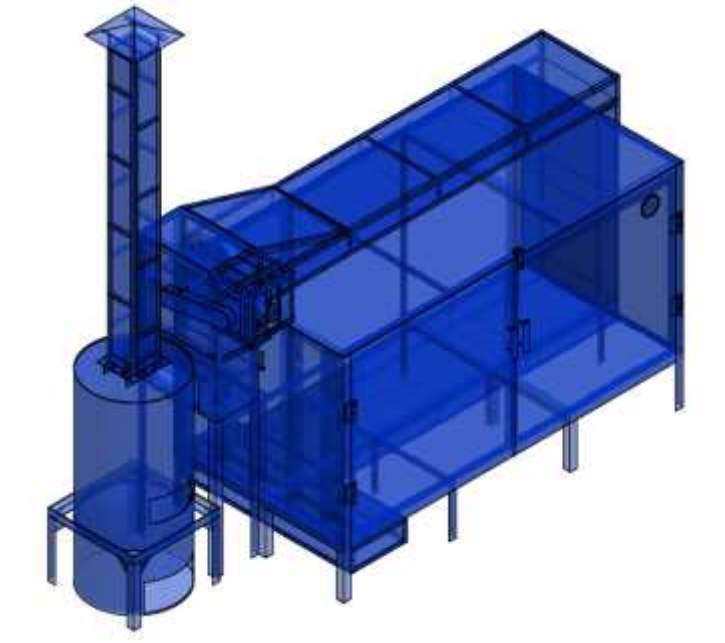

Figure 3. Design of wood drying kilns

Wood drying kiln that be designed is a conventional kiln model where the heat is generated from wood waste burning in the combustion chamber. This heat than sucked to the drying chamber through suction fan. This stream is then released back into the fan suction channel which will carry the flow of hot air from the combustion chamber and drying chamber. This flow is continuously recirculated into the wood drying chamber to achieve the expected dried wood. This model is expected effectively reduce the level of water content with a faster drying time and an efficient fuel consumption. The 3/4 HP electric motor with rotation 1425 rpm is used to rotate suction fan. Wood water content measurement was carried out on 9 point locations. This measurement is carried out periodically within a certain time by using a moisture meter.

a) Data collection and Data analysis

Data collection can be drawn from following steps:

1) Measure the water content of wood before being dried
2) Insert the timber into the drying chamber
3) Prepare the ignition in the combustion chamber to obtain a stable flame with relatively small smoke.
4) Enter the hot air into the drying chamber and keep the heating temperature of 50^{o}C in the first 4 hours and then the temperature of 80 ° C on subsequent heating.
5) Measure the moisture content in wood by using a moisture meter every 2 hours.
6) The measurement is stopped if more than half of the drying wood measurement points have shown the water content of 0%.

Analyses were performed in 9 point measurement to see the level of reduction of water content at each location of drying measurement. This data is very important to be presented as a flow pattern of hot air in the drying chamber. This pattern will be used as a further reference to redesigning the kiln

C. RESULTS AND DISCUSSION

After be constructed in the workshop, the design of the kiln above can be developed as shown in figure 4.

Figure 4. Development of wood drying kiln.

To operate a wood drying kiln, further procedure is employed:

1. Connect the electric motor with the power.
2. Insert the wood waste into the combustion chamber and lit the fire
3. Wait till the fire stable.
4. Turn the ON button on the electric motor to rotate the suction fan. It will suck hot air from the combustion chamber into the wood drying chamber. This process will take place continuously during the drying process.
5. Close the chimney of combustion chamber so that hot air does not leak out.
6. Keep the temperature at 50^{o}C for the first 4 hours and at 80 ° C for the rest.
7. Perform the measurement of the water content every 2 hours.
8. Stop the process if the most of the wood in the drying chamber already showing 0% water content.

Testing of wood drying kiln was conducted to determine whether the kiln is already showing the performance as planned. From the test results known that there is sufficient flow of heated air evenly throughout the drying chamber. Measurement 9 points of water content in the combustion chamber presented in Figure 5.

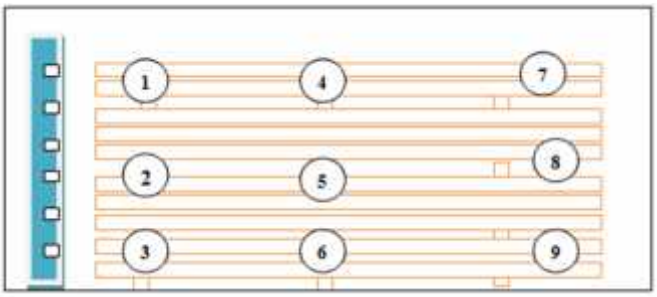

Figure 5. Measuring Locations of Water Content of *rosewood*

Measurements at the points mentioned above are done every interval of 2 hours to obtain the majority of the heated timber containing 0% of the water content. The complete measurement results can be shown in Table 1

Table 1. Water Content of Rosewood Drying

No	Hour	Water Content (%)								
		Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9
1	0	31	29	28	30	36	36	32	28	26
2	2	31	28	28	30	33	34	32	28	26
3	4	30	28	26	29	31	34	29	27	25
4	6	29	27	25	29	31	33	28	26	24
5	8	27	27	23	29	29	30	27	26	24
6	10	26	26	23	28	27	30	26	25	22
7	12	26	25	22	28	24	28	25	24	22
8	14	24	25	20	26	20	27	21	23	21
9	16	23	24	20	26	19	24	21	23	20
10	18	23	23	19	26	19	24	20	22	20
11	20	9	13	19	24	18	18	17	18	19
12	22	1	10	13	17	15	15	13	16	18
13	24	0	5	11	9	11	16	8	14	18
14	26	0	2	10	6	8	11	4	11	17
15	28	0	1	10	3	8	11	3	9	16
16	30	0	0	8	2	6	10	2	7	16
17	32	0	0	7	1	5	9	0	6	15
18	34	0	0	7	0	5	7	0	6	13
19	36	0	0	6	0	5	6	0	6	16
20	38	0	0	5	0	4	6	0	5	16
21	40	0	0	4	0	0	6	0	4	16

The table above shows that the rate of water content varies in each point. The fastest drying starts from point 1, 2, 7, 4 and 5. The latest drying starts from the point of 9, 6, 3, and 8. These data indicate that the area adjacent to the upper heat source would dry first when compared with other regions. On the other hand the area opposite the heat source at the bottom will have the latest drying. This form explains that the half-diagonal upper region, adjacent to the heat, will dry out first, while the other half diagonal will dry more slowly. Heating was performed during 40 hours and showed that the water content in the wood varies between 0% - 16% which 6 points with water content 0%, 2 points with water content of 4% - 6%, and 1 point with water content 16%. Data from nine points, according to Budianto, show the result meet to the export quality wood.

D. CONCLUSION

Wood drying kiln designed to this program is in conformity with what was expected earlier. The results of wood measurements at nine locations in the drying chamber showed that the wood drying occurs varies with water content between 0% - 16%. There are 6 point with water content 0%, 2 points with water content between 4% -6% and 1 point with 16% water content. The results of these measurements indicate that all products can already be used for export quality wood products.

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