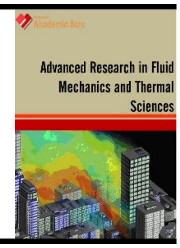
Penerbit Akademia Baru

Journal of Advanced Research in Fluid Mechanics and Thermal Sciences

Journal homepage: www.akademiabaru.com/arfmts.html
ISSN: 2289-7879



Effectiveness of Corn Cob as a Thermal Isolation Material

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ARTICLE INFO

Article history:
Received 3 June 2018
Received in revised form 23 July 2018
Accepted 12 September 2018
Available online 26 September 2018

ABSTRACT

Each year global warming creates a phenomenon of increased heat in building structures, especially indoor. At present, building constructions apply various new materials which focus only on load-bearing material strength in order to be stronger and more durable. However, in order to achieve these criteria, the materials have to be good thermal conductors. Therefore, in this study, in order to overcome this, an alternative material, namely corncob was studied to determine its effectiveness as a thermal isolation material. Dried corncob was ground, glued and compacted in a mold with dimensions of 0.3m x 0.3m x 0.02m to produce a corncob plate. After being dried at 130°C and at room temperature for a day, it was installed on the mini house ceiling. The findings showed that on the third day of experiment, the indoor temperature of the mini house demonstrated a significant difference, where the temperature reading outside and inside the model house showed p-value (of the T-test) of more than 0.05. This proves that the corncob is effective in reducing indoor temperature and it can be an alternative material for thermal isolation.

Keywords:
corncob, thermal isolation, heat conductive material, global warming, construction material

1. Introduction

Malaysia is a developing country that is undergoing rapid urbanization. Skyscrapers are heavily built especially in urban areas. In line with the new developments, new terms such as "intelligent building" and "high-tech" were introduced. New housing estates are built in large and small urban areas. Nevertheless, most buildings are still underdeveloped with climate-compatible features. Materials that absorb and store heat, such as zinc roofs, concrete and other materials, are widely used without understanding the concept of effective thermal insulation [1]. In the context of housing, occupants often complain about discomforts due to hot indoor temperatures. The situation got worse when Malaysia was hit by the El Nino phenomenon in 2016 [2]. Consequently, many take the initiative to install air-conditioners that are known to cause global warming [3]. People are now more affected by the new designs and building materials that are supposed to be stronger and durable

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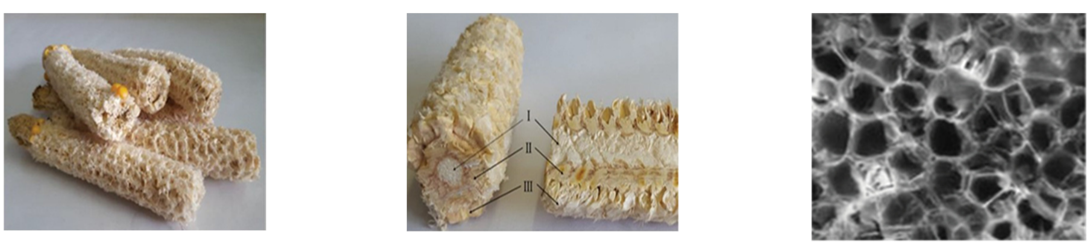
without assessing the side effects. This is due to the lack of emphasis on "Climate-Based Design" in home designs in our country. In this case, the materials used for building houses are now good thermal conductors and are incapable of separating terms over traditional materials that are good thermal separation materials. Additionally, building design factors that do not focus on solar or wind direction are aggravating the condition [4] and increasing indoor temperature. Among the factors that cause the increase in indoor temperatures are heat and conduction heat from the outdoor through walls and roofs. Therefore, this paper intends to find an alternative solution by using waste as the thermal insulation mechanism. The objectives of this project are to reduce existing waste capacity, to use waste corncob (Figure 1) as a heat extinguisher mechanism and to study the difference between outdoor and indoor temperatures after installing the waste (corncob) on one of the structures inside the mini house. It should be noted that the dimensions of the house were 1.3 m long, 1.3 m wide, and 1.3 m high (Figure 2).

Fig. 1. Corn cob waste

Fig. 2. Mini House

2. Characteristics of Corn Cob

Corn cob is a raw organic material that contains a variety of properties. Material discontinuities and anisotropy are also characteristics of corn cob, Figure 3 (a). In terms of macrostructure, corn cob shows three different layers (layer I-III, from outside to inside; Figure 3(b), which can be clearly seen based on color, texture and shape [5]. The layer I is quite soft, the layer II is the same as solid soft wood while layer III is uneven. Figure 3 (c) shows the macro layer I of corn cob, whose closed cellular structure is the same as kind of thermal separation material such as “extruded polystyrene” (XPS) and “expanded polystyrene” (EPS).



(a) (b) (c)

Fig. 3. Macro structure of corn cob. (a) General view point (b) Cross section (c) Macro structure of layer I of corn cob (400µm) [5]

The density of the corncob was measured via an experiment. In the experiment, the average value of the corncob density was 212.11 kg/m3, with a variation of coefficient of 22.4%, which was expected to match corncob characteristics. By comparing the density value with the latest thermal insulation properties of density, it can be concluded that the density of the corncob was higher than that of XPS and EPS, with densities of 25 - 40 kg/m3 and 10 - 25 kg/m3, respectively. This research is important to overcome the internal heat problem that the public is going through. It also brings other benefits in reducing waste as some can still be used when recycled. Besides, it can also reduce waste disposal cost such as that of the corncobs and at the same time generates a new income as the corncobs can be commercialized.

3. Methodology

3.1 Material, Equipment and Prototype Production Techniques

Various materials and equipment were used to create successful prototype production process, such as corncobs, grinding machine and mold. Several studies to make this prototype easier were available and suggestions were made such as the use of tapioca flour to reduce the cost of producing the prototype. The ratio of glue to corncob used to produce the panel was 1:1. The mold was made of steel plate. In order to obtain fine corncob granules, the grinding technique was used because the production of fine corncob granules facilitates the work of preparing the prototype besides adding innovation and aesthetics values to it. Next was the compression technique which compressed the glued corncob into the 0.3m x 0.3m x 0.02m steel mold (Figure 4).

Finally, the last stage was the drying process. It used the drying technique to ensure that the prototype was completely dry to undergo the experimental process. The technique also helped these prototypes (Figure 5) so they can be used in the built-up model house with ease. The construction of the mini house was done at a place where the surrounding area was not blocked with other building structures and trees within the perimeter of 5m. This was to ensure that the mini house will receive optimum heat from the sun. The temperature of the house was recorded as the original temperature reading. By repeating an experiment several times, it will help to determine whether the data is a fluke or it represents the normal case. It also helps to avoid jumping into conclusion without gathering enough evidence. The number of repeats depends on many factors, including the spread of data and the availability of resources.

Three repeats are usually a good starting place to evaluate the spread of data. The three-day period was chosen based on ISO 9869 [6]. Once ready, the dried corncob plate was attached to the structure of the mini house. The temperature inside the house, which was already attached with a particle board, was taken and compared with the temperature outside the house. A comparison between the indoor and outdoor temperatures was made and discussed.

Fig. 4. Steel plate mold

Fig. 5. Compress corn cob plate

4. Results and Discussion

Based on the 3-day data obtained, it was found that the indoor temperature decreased after the corn panel was plastered on the ceiling. Based on the observation of data (Figure 6 until Figure 8), the outdoor and indoor temperatures had insignificant difference with p-values (probability value), obtained from the analysis using T-Test, of 0.23, 0.24, and 0.03 on the first, second and third day, respectively. As can be seen, the difference between the first and second day was more than 0.05 and for the third day, it was less than 0.05, which showed that the data were particularly noticeable, especially between minute 30 and 40. This was so because, the corn panel was just patched and it took some time to see the changes and results. Although the data obtained were desirable, it was still unsatisfactory because the values of temperature differences between the outdoor and indoor temperatures were small.

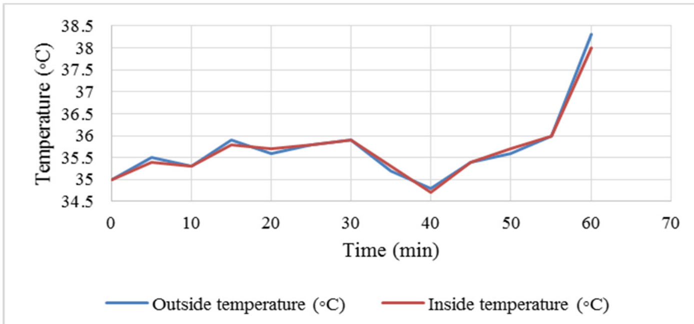


Fig. 6. Temperature vs. Time (First day)

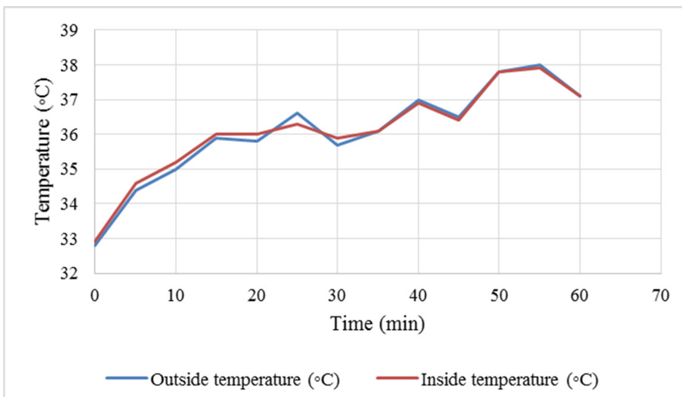


Fig. 7. Temperature vs. Time (Second day)

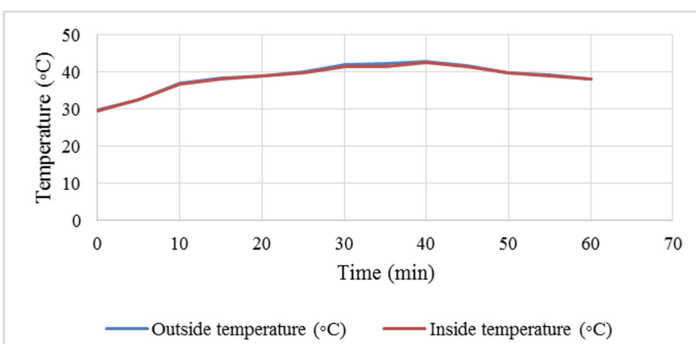


Fig. 8. Temperature vs. Time (Third day)

During the experiment and analysis, we found few errors that maybe could affect the data obtained especially small differences between outside and inside mini house temperature. The factors that caused the errors can be classified as below.

i. Type of roof used
The mini house used zinc roof because it absorbed more heat directly than other roof types. It was assumed that the use of roofs other than the zinc roof were likely to provide a large temperature difference between the indoor and outdoor temperatures, as the outside temperature was higher than that of the inside.

ii. Wall
A fine house has plastered walls. However, the mini house was not plastered. Unplowed house will have warmer walls than the house with plastered walls.

iii. Height
The dimensions of the mini house were 1.3m x 1.3m x 1.3m, while the height of a fine house should be between 3m to 3.5m. It can be said that, the higher the height, the better the air circulation.

iv. Less ventilation
The mini house had no windows and only had tiny spaces for airflow purposes. This led to the increase of the indoor temperature. When the ceiling was attached with the corn panel, the difference cannot be seen because it was insignificant.

5. Conclusion

In conclusion, this research findings will be used to educate people of the usage of corn cob especially as a thermal insulation material in the construction instead it's become waste material and affect the environment. Therefore, to ensure the effectiveness of this material to become a good thermal isolation material, the factors that caused errors in this research should be avoided. Although the mini house was only used for research purposes, it must be constructed similar with the normal houses to obtain more accurate data. In addition, in order to get the right data, the roof of the house should also be constructed properly as the roof is an important factor and should be emphasized in the construction of the house. Roofs should also be built with the appropriate angle slopes because in this study, it was found that the roof greatly affected the data. This is because the roof is the main component that receives heat directly. Based on the current study, the corn panels were found to be more suitable to be attached on the ceiling than on the walls. This is so because, the corn panels are not waterproof so they are not suitable to be plastered on the outer wall of the house. Overall, the objectives of this study were achieved and it can be concluded that corncob is an effective material for thermal.

Acknowledgement
This research has funded by Universiti Tun Hussein Onn Malaysia (Short Term Grant, Grant no. U662. We are also grateful to technicians in Material Laboratory, E17, Timber Laboratory and Geotechnic Laboratory from Universiti Tun Hussein Onn Malaysia (UTHM) for their help in completing this project research in Johor.

References

[1] Ayagi, Kabiru Musa. "Investigating Thermal Comfort of Abandoned Low Cost Houses in Sarawak Based on Construction Materials." PhD diss., Universiti Malaysia Sarawak, 2012.
[2] BERNAMA.'Strong' El Nino to cause low rainfall in Malaysia. Retrieved May 14, 2017, from http://www.malaysiakini.com/news/326165 (2016)

[3] Newell, T. A. *A Report on Global Warming and Energy Consumption Trends of Major Appliances*. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign., 1996.

[4] Talarosha, Basaria. "Menciptakan kenyamanan thermal dalam bangunan." *Jurnal Sistem Teknik Industri* 6, no. 3 (2005).

[5] Pinto, Jorge, Anabela Paiva, Humberto Varum, Ana Costa, Daniel Cruz, Sandra Pereira, Lisete Fernandes, Pedro Tavares, and Jitendra Agarwal. "Corn's cob as a potential ecological thermal insulation material." *Energy and Buildings* 43, no. 8 (2011): 1985-1990.

[6] Pinto, Jorge, Daniel Cruz, Anabela Paiva, Sandra Pereira, Pedro Tavares, Lisete Fernandes, and Humberto Varum. "Characterization of corn cob as a possible raw building material." *Construction and Building Materials* 34 (2012): 28-33.

[7] ISO - International Organization for Standardization. (2014, July 29). Retrieved May 14, 2017,