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Cooling System of Zinc Roofed House by Using Circulated Water

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Abstract. Most traditional village houses uses corrugated zinc roofing due to economic reason. Thermal discomfort will result as zinc is a highly heat absorbing material. The space under the zinc covering will experience significant temperature increase proportional to the amount of supplied heat from sunlight, and this will further be aggravated if the ventilation is poor. The purpose of this study is to determine an alternative method to lower the temperature inside a zinc covered house. The proposed method is by splashing water throughout the area of the zinc roofing, where heat exchange process will occur upon contact. The process will dissipate heat from the zinc but will increase the water temperature. Heated water will then free fall by gravity into a tank through perforated tube with very fine aperture, as water droplet. By the same heat transfer process, ambient air will lower the water temperature, which will be recirculation back to the roof. To facilitate higher rate of water cooling, fan will be provided. The tests show the system was able to lower the temperature of the zinc covered house, and can reduce cost of cooling, thus suitable for low income rural population in Malaysia.

Introduction

In traditional rural Malay community, the majority of dwellers still lived in house covered with roofing made from corrugated zinc sheet. This selection have the advantage of being cost effective as it is cheap, easy to construct and durable However, this selection also have it own drawback when thermal comfort in the living space covered by the roof is sacrificed. This happens because zinc, is good heat conductor and will efficiently absorb heat from sunlight and release it down into the living space through conduction process. The problem will be amplify if the dwelling does not have proper opening to promote natural ventilation as mini heat island phenomena will gradually developed. Coupled with global warming effect which already increases ambient temperature higher than normal, the level of thermal discomfort will be unbearable especially in the afternoon [1].

Solution by traditional mechanical system is not viable option as installing air fan will only recirculate the hot air, while using air conditioning unit is beyond economic capability. Thus, an alternatives cooling system which can provide acceptable thermal comfort level and cost effective need to be identified to help the local community. Research using natural resources which are easily available should commence, and the proposed project will utilises recirculated water as cooling agent.

Problem Statement. Zinc, with thermal conductivity value of 116 W/m.k will efficiently absorb heat from sunlight and also efficiently release it down into the living space, primarily through conduction process. Once the zing is heated, it will also release heat into the living space through radiation which is a heat transfer process of transmittance. The circulated air within the living space will than add heat through convection process.

Traditional houses normally have sufficient wind driven natural ventilation, but usually lack the buoyancy driven natural ventilation to accommodate the space area above the windows level [2]. Those two factors above will contribute to the accumulation of heat inside the dwelling space.

Temperatures in the range of 40 to 45 degrees Celsius in the afternoon are normal occurrence. Apart from discomfort, high temperatures are known to cause severe health hazard such as heat stroke.

Objective. The objective of this research is to propose and evaluate an alternative mechanical method to reduce the temperature inside a zinc-roofed house. The proposed method should preferably utilised easily available resources, and should minimized use of energy.

Scope of study. Experimental field data will be collected over a period of time at Kuikwall Centre in Universiti Tun Hussein Onn Malaysia (UTHM). Only temperature data will be collected from two different rooms where one room is selected as experimental room and will be fixed with the proposed alternative cooling method, while the other one is designated as control room and will be left intact. The effect of other factor such as air flow and humidity to temperature variation is not considered as both rooms are deeming to be identical.

Literature Review

Flowing fluid as cooling agent. Law of thermodynamic stated that to achieve state of equilibrium, heat exchange will occur between two materials of different temperature. The direction of heat flow is from the high to lower temperature [3]. Running lower temperature level water over higher temperature level zinc will induce the flow of heat from the later to the former, thus lowering the zinc temperature but increasing the water temperature. By the same principles, passing heated water droplet through flowing air with ambient temperature will achieve the same effect [4].

Heat transfer through phase change. As water filter through the fine aperture of the perforated pipe and in contact with the flowing air, some of the droplet will be converted to finer form of mist which is in transient state between liquid and vapour. The conversion of material between different state (phase change) induce heat transfer and will contribute to lowering the water temperature back to ambient level before it is recirculated again [5].

Methodology

Cooling process. The system uses the concept of recirculating as the main basis process to ensure there would be no wastage of resources and environmentally friendly (Fig. 1 and Fig.2 shown the process of circulation).

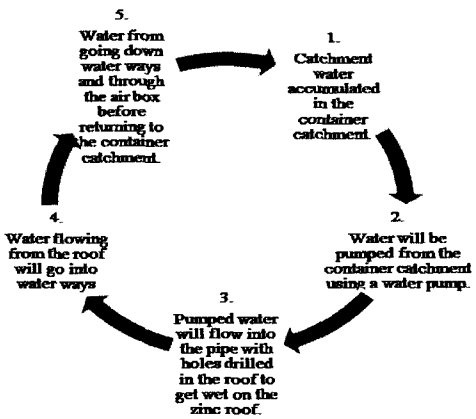

Fig.1: Process cycle schematic

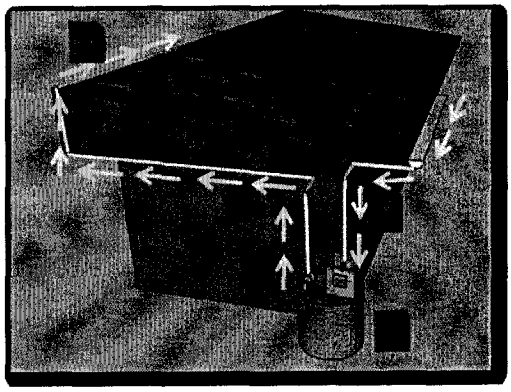

Fig. 2: Physical system

Cooling box fan. In this system, the temperature of hot water was cooled in the box equipped with an exhaust fan. The process of heat transferred from the water occurs when water dripped through the air. Cool water drop back into the tank.

Testing and analysis. Tests were conducted to determine the effectiveness of the system to lower the temperature in the house. Simultaneous temperature reading from both experimental and control room are collected over a period of time. Both of these data were compared to determine their effectiveness. For additional reference, ambient and water temperature in collection tank were also recorded. Tests were conducted from 11 am to 3 pm on the days when there are no sky overcast. Graph of temperature versus time were plotted to determine the effectiveness of the system. The graph is shown in Fig 3.

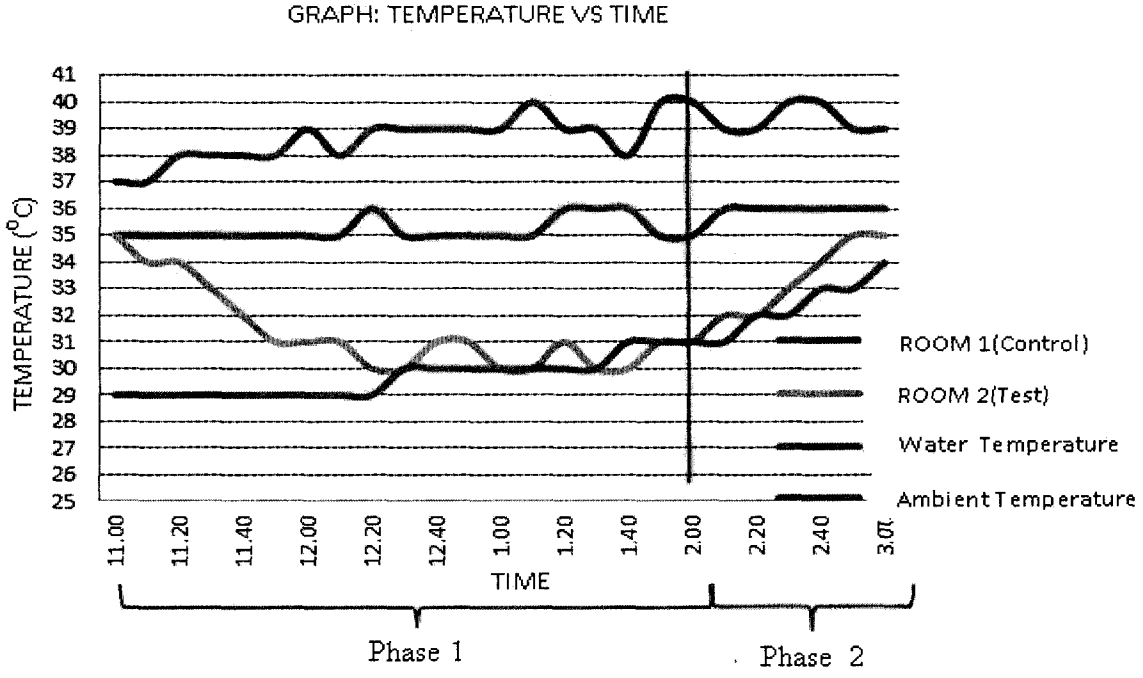

Fig 3: Patterns of temperature

Discussion and suggestion

Temperature variation pattern over time was almost the same for room 1 (control) and ambient temperature, but room temperature was lower by about 5 degrees Celsius throughout. For room 2 (test), the temperature start level with room 1 but distinctively drop further as the system is activated until around 2 pm when the temperature room 2 start to increase gradually and level back with temperature in room 1. At the same time, the temperature of the cooling water had also increased. This showed exhaust fan could not cope with the increase of temperature of the circulating cooling water. More detail study is needed to refuned the system either by changing the size of cooling fan or using different cooling system such as using underground storage water tank.

Conclusion

Proposed cooling system was capable of reducing the temperature inside the house. However, in-depth study of the water cooling system needs to be done effectively. By using this system, those in the zinc-roofed house could enjoy the comfort even on hot, sunny afternoon/evening.

Acknowledgment

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References

[1] Ariff M. M (2008). "Pemanasan Global Menangani Alam". retrieved August 2013 from http://www.savesandakan.com/pemanasan-global-menangani-amarah-alam/.

[2] Muhamad Azraai A. H (2007) Rekabentuk Kipas Penyejuk. Tesis Sarjana Muda. Universiti Teknikal Malaysia Melaka.

[3] Kannan, K S (2009) Asas Termodinamik: Kursus Permulaan. Sekudai : UTM.

[4] Wan Mokhtar W. A (2006) . Ramalan Aliran Haba Dan Jisim Melalui Satu Kipas Penukar Haba Menggunakan Pemodelan CFD. Tesis Sarjana Muda. Universiti Teknikal Malaysia Melaka.

[5] Trost, J. (1999). Heating, ventilating, and air conditioning (11^{ed}.). USA: Prentice Hall.