The Suitability of Porous Material to Simulate Evaporation in Human Sweating Mechanisms

Rhubenthiraan Kelundapyan, Lee Yee Yong, Mohd Azuan Zakaria, Sasitharan Nagapan, Viknheswar Chandira Segaran

Abstract*: This study aims to determine the suitable porous material that can simulate human sweat evaporation rate for preliminary thermal comfort assessment. The objective of the study was to identify the relationship of human sweat evaporation rate with porous material evaporation rate. Field experimental has been conducted to measure the evaporation rate of porous material such as red clay, white clay, plaster and human sweat. Then, the correlation analysis was conducted between porous material evaporation rate and human sweat evaporation rate. The collected data were analyzed by using SPSS 20 and Microsoft Excel 2016 tools. Pearson correlation were used as statistical analysis to find the relationship between both variable. The statistical significance level was set at P< 0.01. Based on the findings, human sweat evaporation rate had a moderate correlation with red clay (r = 0.583) and white clay (r = 0.503) with statistically significant but very weak correlation with plaster (r = 0.020). The porous characteristics of red clay and white clay has the capillary effect which is almost like human skin by showing a good correlation between human sweat and porous material evaporation rate. As this is preliminary study, in future more research to be done to obtain higher correlation between porous material and the human body by modifying the material. To minimize heat stress, it would be a step forward in evaluating outdoor thermal comfort and raising awareness of society and government.

***Keywords*: Human Sweat Loss, Porous Material, Thermal Comfort, Thermal Manikin**

I. INTRODUCTION

The world is growing towards urbanization and it is an alarming social issue for the developing countries [1]. With growing urbanization, the phenomenon of Urban Heat Island (UHI) is becoming more of a concern, with the intensity of UHI is increasing, particularly in many megacities [2]. A UHI is known as a climatic phenomenon in which urban areas have higher air temperature than their surrounding rural area. The UHI effect can caused a person to experience thermal discomfort and likely to expose to heat health illness specially at outdoor condition. Frequent exposure to the heated environment will thus contribute to a decrease in thermal comfort, thus increasing the prevalence of heat-related illness [3]. Therefore, it is essential to evaluate hot environments in order to ensure the health and safety of outdoor individuals [4].

In order to keep people away from heat and discomfort, mitigation and prevention strategies should be introduced. In the aspect of heat stress assessment, the direct method of exposing the human body to direct sunlight or evaluating outdoor thermal comfort is discouraged due to health problem. Therefore, in combination with these mitigation initiatives, the development of thermal manikin in the future research may be useful as a representative of the human simulation model to investigate the occurrence of UHI and to assess thermal comfort under microclimate conditions [5]. The purpose of thermal manikin is to evaluate the effect of human body and simulate human responses in thermal environments [6]. The number of thermal sweating manikins has steadily increased, and many modern thermal manikins are designed with a sweating feature [7]. Since the development of thermal manikin is getting more and more attention, it is possible to include the combination of human factors such as physiological mechanism of thermoregulation by fabricating thermal manikin, thermal sensation by questionnaire survey and thermal comfort indices based on meteorological data to evaluate human thermal comfort in outdoor environment [8]. Therefore, in this study, the porous material will be assess based on human sweat evaporation rate which is indicating physiology.

Based on previous study, there's a lot of sweating manikin has been used worldwide with different material [9]. There is lack manikin that made up from red clay, white clay and plaster till date. However, in 2004, Mendes & Silva had used the porous material of plaster, white clay and red clay to simulate human perspiration and they stated that the porous material has the capillary effect and formation of a humid layer on the external surface of the porous material which is almost similar to human skin. The porous material also has the characteristics such as cooling effect and the evaporation rate based on air temperature is almost same with human skin [10]. Porous materials have shown the capacity to simulate evaporation in human sweating mechanism based on theory. But the researcher never used actual human sweat loss and compare with the porous material. The knowledge gap is existing there. Hence, the aim of this study focused on the investigation of the suitability of porous material such as red clay, white clay and plaster that can simulate human sweating mechanisms. This research was used as a preliminary study to examine the suitability of porous material to become the material in developing the heat indicator for a new generation of manikin suitable for outdoor environments.

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Rhubenthiraan Kelundapyan, Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia.

Lee Yee Yong, Department of Civil Engineering, Faculty of Engineering Universiti Malaysia Sarawak, Kota Samarahan, Malaysia.

Mohd Azuan Zakaria, Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia.

Sasitharan Nagapan, Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia.

Viknheswar Chandira Segaran, Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia.